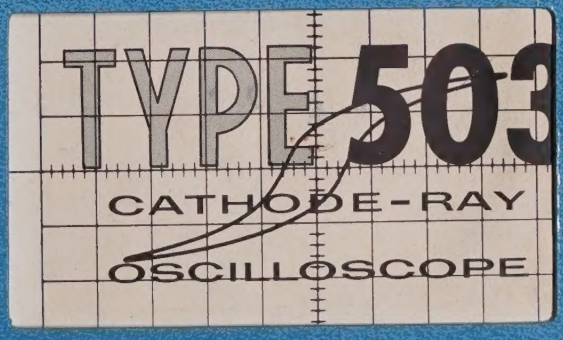
INSTRUCTION MANUAL

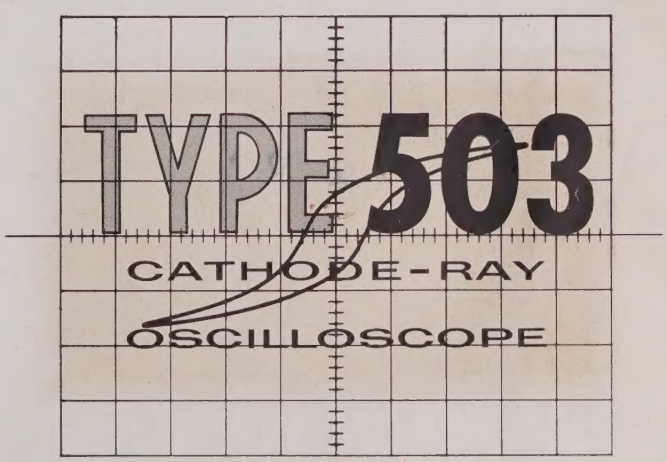


MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

Radiation Department
Room 51.

INSTRUCTION MANUAL

RADIATION
DEPARTMENT
FELTHAM



S/N 4333

Tektronix, Inc.
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Tektronix transformers manufactured in our own plant carry an indefinite warranty.

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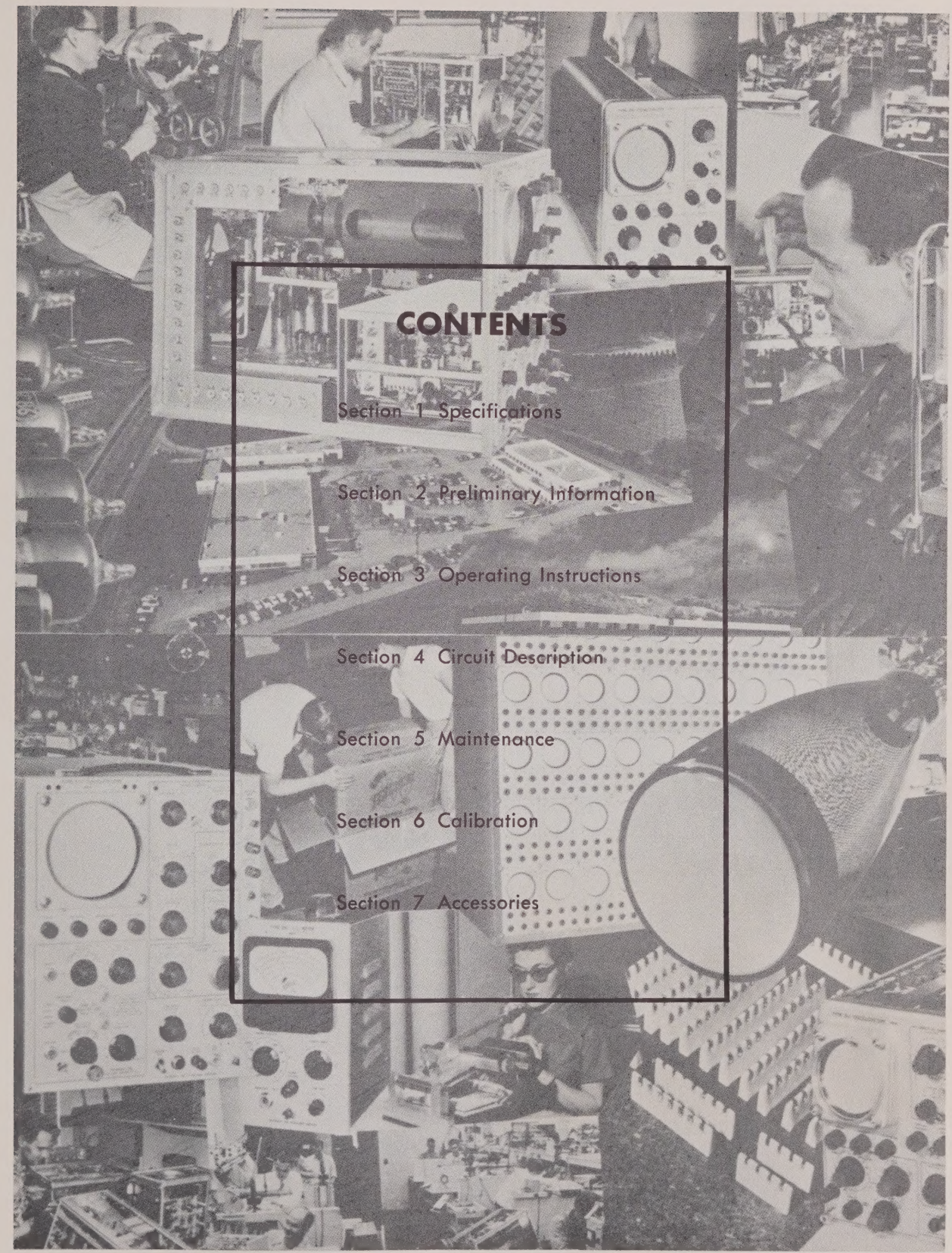

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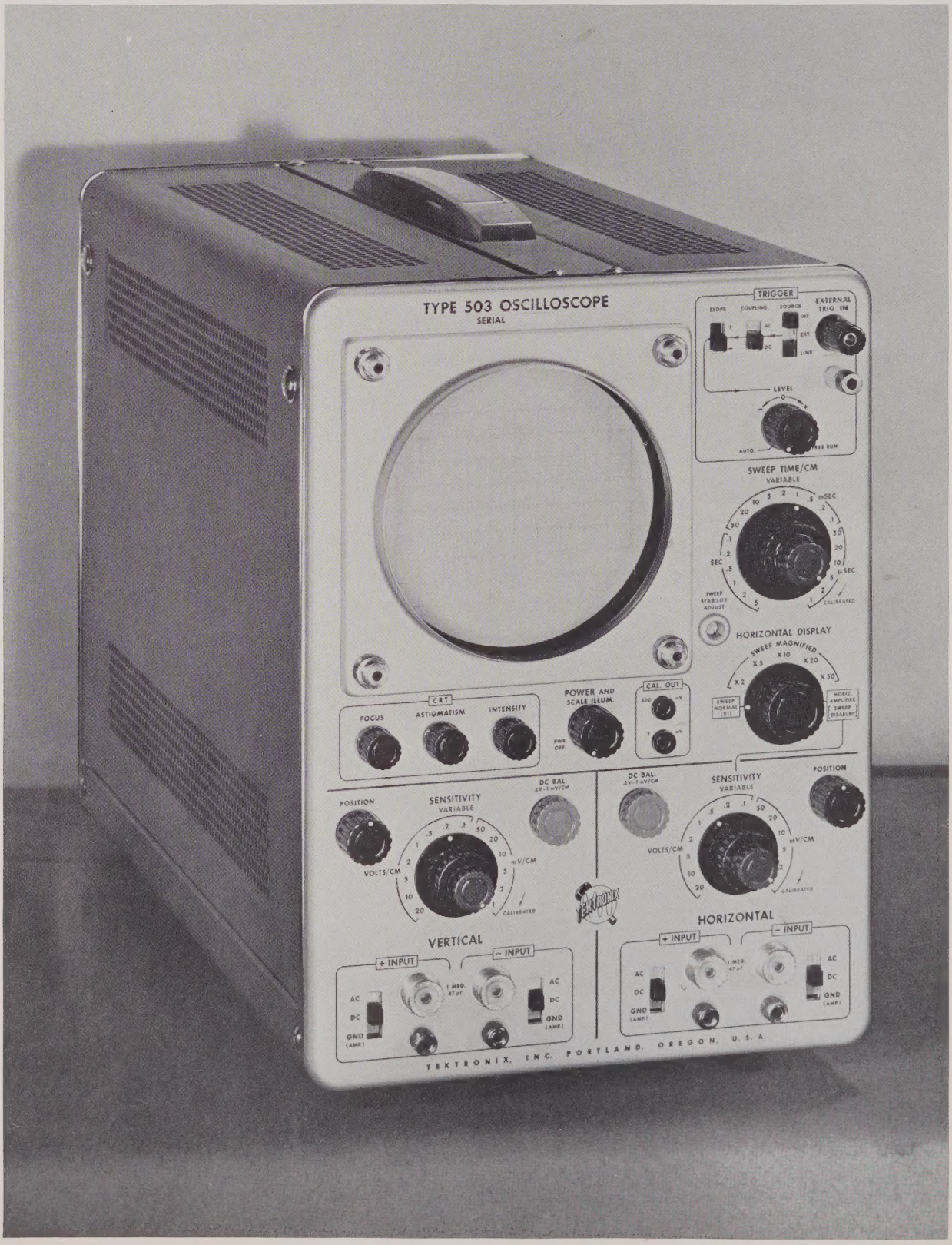
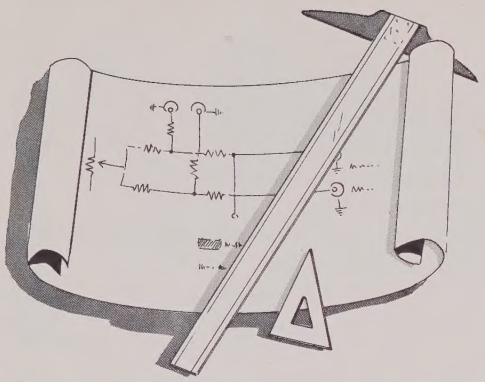

TYPE 503 OSCILLOSCOPE
SERIAL
TRIGGER
SLOPE
COUPLING
SOURCE
EXTERNAL TRIG. IN
LEVEL
AUTO.
FREE RUN
SWEEP TIME/CM
VARIABLE
mSEC
SEC
μSEC
SWEEP STABILITY ADJUST
CALIBRATED
HORIZONTAL DISPLAY
SWEEP MAGNIFIED
X5
X10
X20
X2
X50
SWEEP NORMAL (X1)
HORIZ. AMPLIFIER (SWEEP DISABLED)
CRT
FOCUS
ASTIGMATISM
INTENSITY
POWER AND SCALE ILLUM.
PWR OFF
CAL. OUT
mV
POSITION
SENSITIVITY
VARIABLE
VOLTS/CM
mV/CM
DC BAL.
2V-1 mV/CM
VERTICAL
+ INPUT
- INPUT
AC
DC
GND (AMP.)
1 MEG. 47 pf
HORIZONTAL
TEKTRONIX
TEKTRONIX, INC. PORTLAND, OREGON, U.S.A.



SPECIFICATIONS

Introduction

The Tektronix Type 503 Oscilloscope is a low-frequency, high-sensitivity laboratory instrument providing accurate measurements in the range from dc to 450 kc. Identical vertical and horizontal amplifiers may be used for accurate curve plotting in the X-Y mode of operation. Both amplifiers may be operated with single-ended inputs for conventional operation, or with differential inputs for cancellation of common-mode signals. Sweep rates to 1 microsecond per centimeter, combined with sweep magnification factors to 50, provide effective calibrated sweep rates to 0.1 microsecond per centimeter.

Vertical and Horizontal Deflection System

Input Impedance—1 megohm paralleled by 47$\mu\mu$f.

Coupling—AC or DC

Deflection Factors—Fourteen calibrated deflection factors from 1 millivolt to 20 volts per centimeter, accurate within 3%.

Bandpass—DC to 450 kc.

Differential Input Rejection Ratio—100 to 1 from 1 millivolt to 0.2 volt per centimeter sensitivity; 50 to 1 from 0.5 volt to 20 volts per centimeter sensitivity. The rejection ratios specified apply if the signal voltages at the INPUT connectors do not exceed the following limits: $\pm$2 volts dc, or 4 volts peak-to-peak ac, at sensitivities of 1 millivolt to 0.2 volt per centimeter; $\pm$20 volts dc, or 40 volts peak-to-peak ac, at sensitivities of 0.5 volt to 2 volts per centimeter; $\pm$200 volts dc, or 400 volts peak-to-peak ac, at sensitivities of 5 volts to 20 volts per centimeter.

Triggering

Type—Automatic, or amplitude-level selection using preset stability.

Coupling—AC or DC.

Slope—Plus, from rising slope of triggering waveform, or minus, from negative slope of triggering waveform.

Source—Internal from vertical signal, external from triggering signal, or line from 60 cps, ac.

Signal Requirements—Internal: signal producing 0.5 cm vertical deflection. External: 0.5 volt to 10 volts of either polarity.

Sweep

Type—Miller Integrator.

Rates—Twenty-one calibrated sweep rates from 1 microsecond to 5 seconds per centimeter. Accuracy typically within 1% of the indicated sweep rate; in all cases within 3%.

Magnifier—Displayed waveforms can be expanded horizontally by a factor of 2, 5, 10, 20, or 50. Calibration of magnified sweep rates accurate within 5% of sweep rates which do not exceed the maximum calibrated rate of 0.1 microsecond per centimeter.

Amplitude Calibrator

Waveform—Square waves at approximately 350 cps.

Amplitude—5 millivolts and 500 millivolts peak-to-peak.

Cathode-Ray Tube

Type—T503P

Phosphor—Type P2 normally furnished; P1, P7, and P11 phosphors optional. Other phosphors available on special order.

Accelerating Potential—3000 volts.

Z-Axis Modulation—External terminal permits RC coupling to crt grid.

Graticule

Illumination—Variable edge lighting.

Display Area—Marked in 8 vertical and 10 horizontal 1-centimeter divisions with 2-millimeter markings on the center lines.

Power Supplies

Electronically regulated for stable operation with widely varying line voltages and loads.

Line Voltage Requirements—105 to 125 volts or 210 to 250 volts at 50-60 cycles. Will operate at line frequencies up to 800 cps with higher line voltages (see Section 2).

Power Requirements—Approximately 110 watts.

Mechanical Specifications

Construction—Aluminum alloy chassis and cabinet.

Finish—Photo-etched anodized panel, blue vinyl-finish cabinet.

Dimensions—21¼" long, 9¾" wide, 13½" high.

Weight—29 pounds.

Accessories

2—Type A510 Binding Post Adapters, 013-004
2—Instruction Manuals
1—Parts List and Schematic Diagrams Booklet
1—3 to 2-wire adapter, 103-013
1—3-conductor power cord, permanently attached, 161-017
1—Green Filter, 378-522

PRELIMINARY INFORMATION

Power Requirements

The Type 503 Oscilloscope line transformer primary can be wired for either 117-volt or 234-volt operation, at a line frequency of 50 to 60 cps. At this line frequency, proper regulation of the power supply will be obtained at line voltages between 105 volts and 125 volts when the line transformer is wired for 117-volt operation and between 210 volts and 250 volts when the line transformer is wired for 234-volt operation. Fig. 2-1 shows the transformer connections required for each range of operation.

The Type 503 Oscilloscope can be operated at any ac line frequency from 50 cps up to 800 cps, although higher line voltages are required at the higher line frequencies. At an ac line frequency of 400 cps, the nominal and lower and upper limits are about 10% higher than at 50-60 cps. At a line frequency of 800 cps, the nominal and lower and upper limits are about 15% higher than at 50-60 cps. At line frequencies between the specific values given, the required line voltages will be proportionately larger or smaller. For maximum dependability and long life, it is recommended that the line voltage be kept at or slightly below the nominal.

Fuse Requirements

Use a 1.25-amp slow-blowing type fuse when the Type 503 is wired for 117-volt operation. Use a 0.7-amp slow-blowing type fuse when the Type 503 is wired for 234-volt operation.

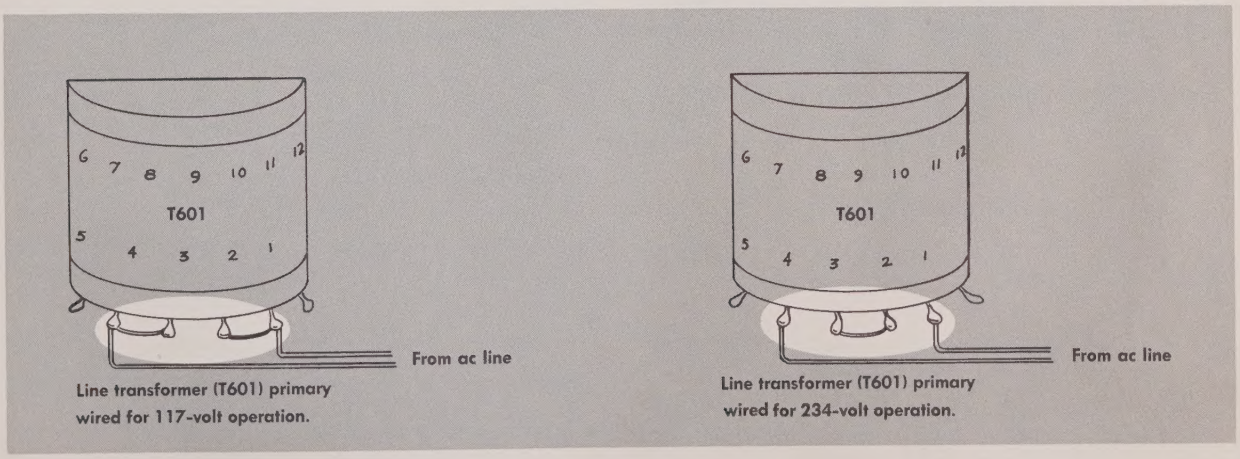


Fig. 2-1. Line transformer wired for 117- and 234-volt operation.

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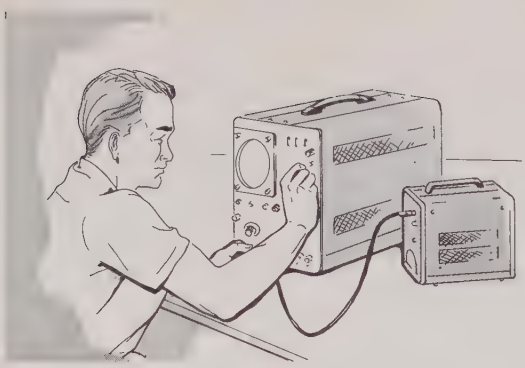
SECTION 3



OPERATING INSTRUCTIONS

FRONT PANEL CONTROLS AND CONNECTORS

The front panel of the Type 503 Oscilloscope is shown in Fig. 3-1. Functions of all front panel controls and connectors are described in Table 3-1.

TABLE 3-1

SLOPE	Determines whether triggering occurs on rising portion (+ slope) or falling portion (— slope) of triggering waveform.
COUPLING	Selects whether triggering will occur at a specific dc level or at an ac level.
SOURCE	Selects the source of the triggering signal.
EXTERNAL TRIG. IN	Input connector for external triggering signals.
LEVEL	Selects the voltage point on the triggering waveform at which the horizontal sweep is triggered. This control also selects automatic triggering (AUTO. position) or allows the sweep to free run (FREE RUN position.)
SWEEP TIME/CM	Selects the desired horizontal sweep rate from a choice of 21 calibrated steps.
SWEEP TIME/CM VARIABLE (red)	Provides a continuous range of sweep rates between the fixed steps selected by the SWEEP TIME/CM switch. (The sweep rates are calibrated only when the VARIABLE control is set fully clockwise to the CALIBRATED position.)
SWEEP STABILITY ADJUST	Provides for a stable presentation when the LEVEL control is in the AUTO. position.
FOCUS	Focuses the trace or spot on the screen.
ASTIGMATISM	Controls roundness of the spot on the screen. (This control is located inside on instruments with serial numbers 000270 and above).
INTENSITY	Controls the brightness of the trace or spot on the screen.
POWER AND SCALE ILLUM.	Turns instrument power on and off, and controls graticule illumination.
CAL. OUT connectors	Provide amplitude-calibrated square waves of 5 and 500 millivolts for use in calibrating gain of amplifiers.
HORIZONTAL DISPLAY	Selects conventional (horizontal sweep) or X-Y mode of operation. Also provides magnification of sweep rate selected by SWEEP TIME/CM control.
	VERTICAL CHANNEL
POSITION	Controls vertical positioning of the display on the screen.
SENSITIVITY	Selects the sensitivity of the Vertical Amplifier from 14 calibrated steps.
SENSITIVITY VARIABLE (red)	Provides a continuous range of sensitivity values between the fixed calibrated steps selected by SENSITIVITY control. (Normally, sensitivity is calibrated only when VARIABLE control is in CALIBRATED position.)
DC BAL.	Provides for vertical stability of no-signal trace for all positions of the SENSITIVITY control.
+INPUT and — INPUT connectors	Input connectors for signal to be displayed vertically. (Signals connected to the —INPUT connector will be displayed inverted.)
+INPUT and —INPUT switches	Select desired coupling for incoming signal.
	HORIZONTAL CHANNEL
DC BAL.	Provides for horizontal stability of no-signal trace for all positions of SENSITIVITY control.
SENSITIVITY	Selects the sensitivity of the Horizontal Amplifier from 14 calibrated steps.
SENSITIVITY VARIABLE (red)	Provides a continuous range of sensitivity values between the fixed calibrated steps selected by the SENSITIVITY control. (Normally, sensitivity is calibrated only when VARIABLE control is in CALIBRATED position.)
POSITION	Controls horizontal positioning of the display on the screen.

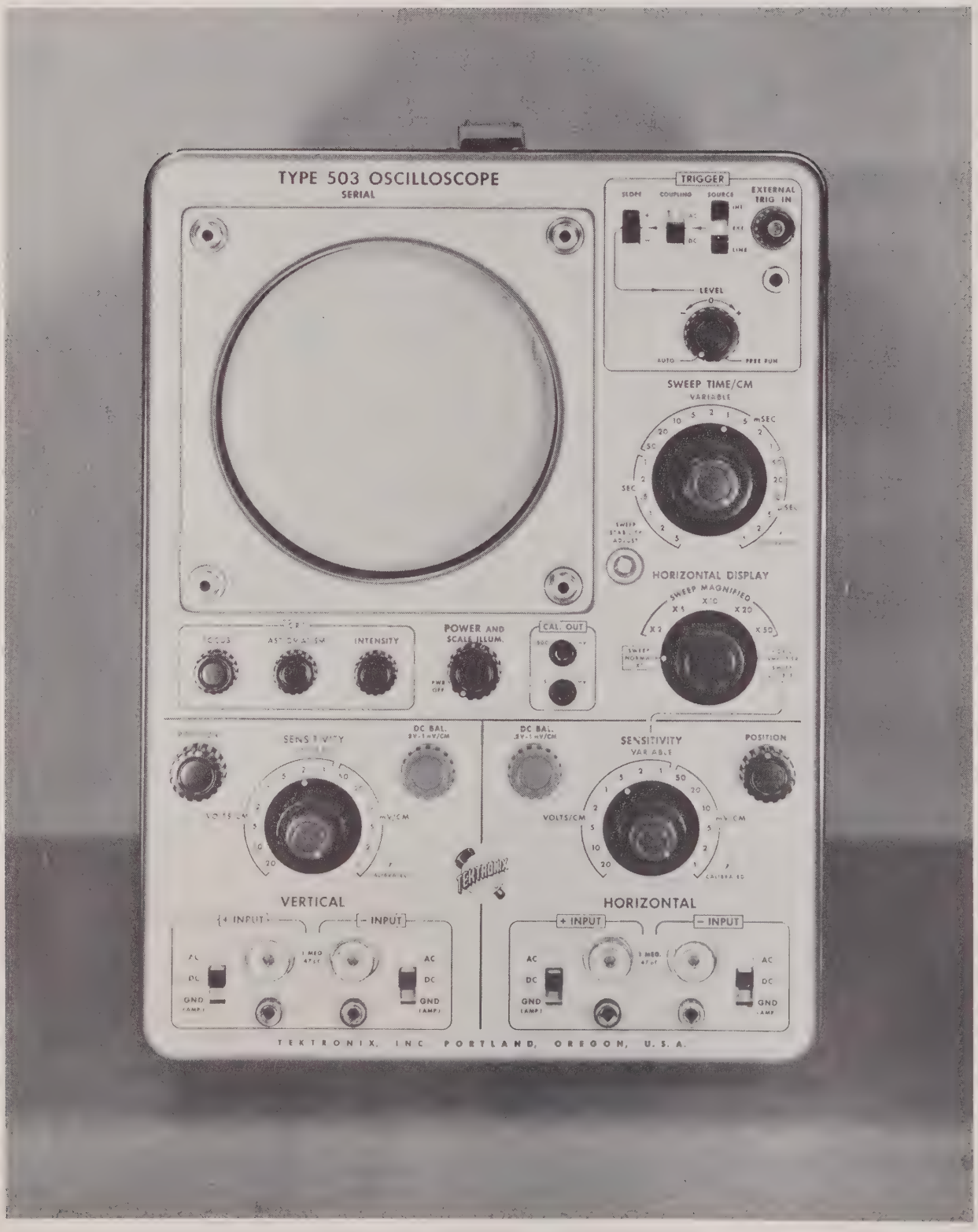


Fig. 3-1. Type 503 Oscilloscope front panel.

+ INPUT and — INPUT connectors	Input connectors for signal to be displayed horizontally. (Signals connected to the —INPUT connector will be displayed inverted.)
+ INPUT and —INPUT switches	Select desired coupling for incoming signal.

PRELIMINARY INSTRUCTIONS

To initially set up the Type 503 Oscilloscope for operation, proceed as follows:

1. Connect the oscilloscope to a suitable source of power (refer to Section 2 of this manual), and turn the POWER switch clockwise from the POWER OFF position. Set the INTENSITY control fully counterclockwise. Let the instrument warm up for about 5 minutes.

2. Set the HORIZONTAL DISPLAY switch to the HORIZ. AMPLIFIER position.

3. Set all of the INPUT switches to the GND position.

4. Set the two SENSITIVITY switches to the .2 VOLTS/CM position and the SENSITIVITY VARIABLE controls to the CALIBRATED position (fully clockwise until they snap into position).

5. Set both POSITION controls to mid-range and advance the INTENSITY control to produce a spot on the screen. The INTENSITY control should be set to produce an easily seen, but not bright, spot. Too bright a spot may damage the phosphor on the face of the crt. The intensity should never be turned up to the point where a halo forms around the spot.

6. Adjust the FOCUS control to produce the smallest, roundest spot possible. Note the position of the spot on the crt.

7. Set the VERTICAL SENSITIVITY control to the 1 mV/CM position. Make sure that the SENSITIVITY VARIABLE control has remained in the CALIBRATED position.

8. With the VERTICAL DC. BAL. control, move the spot back to where it was in step 6.

9. Set the HORIZONTAL SENSITIVITY control to the 1 mV/CM position. Make sure that the SENSITIVITY VARIABLE control has remained in the CALIBRATED position.

10. With the HORIZONTAL DC BAL. control, move the spot back to where it was in step 6.

11. Adjust both DC BAL. controls so that the spot does not move as the SENSITIVITY controls are moved from the .2 VOLTS/CM position to the 1 mV/CM position.

The amplifiers in the oscilloscope are now balanced and the oscilloscope is ready for operation as described in the remainder of this section.

Graticule Illumination

Graticule illumination can be adjusted to suit the lighting conditions of the room by means of the POWER AND SCALE ILLUM. control. Turning the control clockwise (but not to the PWR. OFF position) increases the graticule illumination. It is possible to extinguish the graticule illumination completely by turning the control fully clockwise.

The graticule of the Type 503 Oscilloscope can be illuminated so that it appears to have either red or white graticule markings. The markings can be changed from white to red or red to white simply by removing the graticule cover and inverting the graticule. As a general rule, white graticule lines are superior to red for photographic purposes.

INPUT SELECTION

Two INPUT connectors and associated INPUT switches are provided in each channel. When a single input is used, it may be applied through either the +INPUT or —INPUT connector. If the signal is connected to the +INPUT connector, the +INPUT switch should be placed in either the AC or DC position, depending upon the type of coupling desired. The —INPUT switch should be placed in the GND position. If the signal is connected to the —INPUT connector, the —INPUT switch should be placed in either the AC or DC position, and the +INPUT switch should be placed in the GND position. It should be noted that when a signal is applied to the —INPUT connector of either channel, the display on the oscilloscope screen will be opposite in polarity to a normal presentation. Conventionally, a normal display places the more positive portions of a waveform in the vertical channel toward the top of the screen, and the more positive portions of a waveform in the horizontal channel toward the right-hand side of the screen.

When it is desired to display the difference between two signals, they are connected to the two INPUT connectors of the appropriate channel. In this case, both INPUT switches are placed in either the AC or DC positions. In this mode of operation, the two signals are subtracted from each other algebraically, and the difference is displayed as a single trace on the screen. This is called the "differential" mode of operation. It permits you to eliminate signals which are common to both inputs and to observe a waveform which is peculiar to one. Figs. 3-2 and 3-3 show the effects of application of signals to one or both INPUT connectors of the vertical channel.

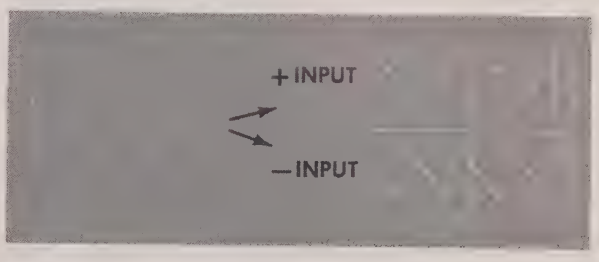


Fig. 3-2. Inputs to the vertical amplifiers.

Waveforms applied to the + INPUT connectors are displayed in the upright position, while waveforms applied to the — INPUT connectors are inverted.

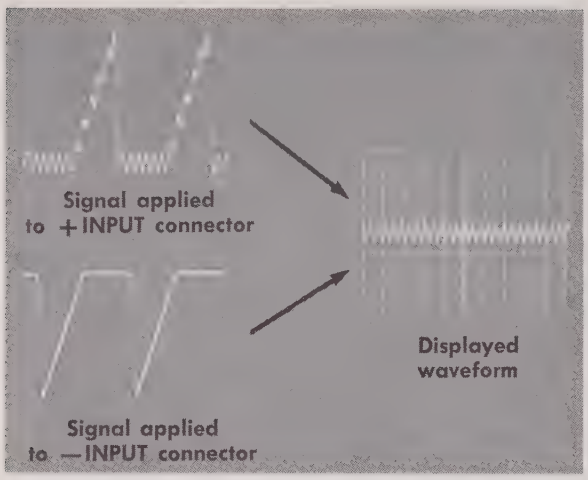


Fig. 3-3. Rejection of common mode signal by differential operation.

The signal applied to the — INPUT connector is algebraically subtracted from the signal applied to the + INPUT connector and the difference waveform is displayed on the crt screen.

The differential mode of operation also makes possible the observation of current changes in a circuit. The changes in the voltage drop across a given resistor are proportional to the changes in current through it. So a differential display of the voltages at the two ends of a resistor will show the changes in current through the resistor.

Input Coupling

Input signals to both the vertical and horizontal channels can be either ac or dc coupled by placing the corresponding INPUT switches to the appropriate positions. Dc coupling applies both the ac and dc components of the input signal to the amplifier circuits. This permits you to measure the dc voltage level as well as the amplitude of the ac component. However, it is sometimes neither necessary nor desirable to display the dc component, and in such cases ac coupling should be used. With ac coupling, a capacitor is placed in series with the input connector to block the dc component while allowing the ac component to be displayed.

CONVENTIONAL OSCILLOSCOPE OPERATION

Placing the HORIZONTAL DISPLAY switch in the SWEEP NORMAL position sets the Type 503 Oscilloscope up for conventional oscilloscope operation. In this mode of operation, an internally generated horizontal sweep is applied through the horizontal amplifier to the horizontal deflection plates of the crt, and the input signal is applied through the vertical amplifier to the vertical deflection plates.

The Type 503 Oscilloscope allows you to select, with the SWEEP TIME/CM control, any one of 21 calibrated sweep rates ranging, in steps, from 1 microsecond to 5 seconds per centimeter. The SWEEP TIME/CM VARIABLE control makes it possible to obtain a continuous range of sweep rates between the steps selected by the SWEEP TIME/CM control. However, all sweep rates obtained with the SWEEP TIME/CM VARIABLE control in any position but fully clockwise are uncalibrated.

Sweep Triggering

In order to obtain a stable display, it is necessary to start the horizontal sweep consistently at the same time relative to recurring cycles of the input waveform. The sweep therefore must be triggered by the input waveform itself or by some waveform which bears a fixed time relationship to the input waveform. The following instructions tell you how to select and use the proper triggering signal for various applications of the oscilloscope.

Selecting the Trigger Source

For most applications the sweep can be triggered by the input waveform. The only requirement is that the input signal be large enough to provide at least 0.5 centimeter of deflection on the screen at the sensitivity level for which the VERTICAL SENSITIVITY control is set. To obtain triggering of the sweep from the input waveform, set the SOURCE switch to the INT. position.

Sometimes it is advantageous to trigger the sweep with some external signal. This is especially true when the input waveform is of such small magnitude that it cannot provide stable triggering of the sweep by itself. External triggering is also useful where waveforms are going to be sampled from several different places within a device. By using external triggering, it is not necessary to reset the triggering controls each time a new waveform is shown. In order to obtain a stable display, it is necessary that the external waveform bear a fixed time relationship to the input waveform. To use an external waveform for triggering the horizontal sweep, connect the signal to the EXTERNAL TRIG. IN connector and set the SOURCE switch to the EXT. position.

When you are observing a waveform which bears a fixed time relationship to the line frequency, you may wish to trigger the sweep from the line-frequency waveform. To do this, place the SOURCE switch in the LINE position.

Selecting the Trigger Coupling

For most recurrent waveforms, ac coupling of the triggering signal (COUPLING switch in the AC position) will provide satisfactory triggering of the sweep. Dc coupling of the triggering signal (COUPLING switch in the DC position) is particularly useful in triggering from random pulse trains or very low frequency waveforms. With dc coupling the sweep is triggered by an instantaneous dc voltage. With ac coupling the sweep is triggered when the signal reaches a given amplitude from its average dc level.

Selecting the Trigger Slope

When the SLOPE switch is in the + position, the sweep is triggered on a positive-going slope of the triggering signal. When the SLOPE switch is in the — position, the sweep is

triggered on a negative-going slope of the triggering signal. In most cases, selection of the triggering slope is not critical since triggering on either slope will provide a display which is suitable.

Selecting the Trigger Level

The LEVEL control determines the instantaneous voltage level (ac or dc, depending upon the setting of the COUPLING switch) on the triggering signal at which the sweep is triggered. With the SLOPE switch in the + position, adjustment of the LEVEL control makes it possible to trigger the sweep consistently at virtually any point on the positive-going slope of the triggering signal. Likewise, with the SLOPE switch in the — position, adjustment of the LEVEL control makes it possible to trigger the sweep consistently at virtually any point on the negative-going slope of the triggering signal. Fig. 3-4 shows the effects of the LEVEL control and the SLOPE switch.

At the extreme clockwise and counterclockwise ends of its range, the LEVEL switch activates, respectively, the FREE RUN and AUTO. switches. The effects of these switches are discussed in the following paragraphs.

Automatic Mode of Operation

Setting the LEVEL control fully counterclockwise to the AUTO. position sets the Type 503 Oscilloscope up for an automatic mode of triggering which is suitable for most applications. In this mode, the triggering signal is ac coupled, and the triggering level is automatically set such that any external triggering signal of one volt or more, or internal triggering signal which would produce 1 centimeter or more of deflection on the crt screen, will trigger the sweep. In the absence of such a triggering signal, the sweep will continue to be triggered automatically at about a 50-cps rate to produce a base line which indicates that the instrument is adjusted to display any signal which might be connected to the vertical channel.

Free-Running Mode of Operation

Setting the LEVEL control fully clockwise to the FREE RUN position produces a free-running sweep, independent of any synchronizing signal. The frequency of the free-running sweep is dependent upon the setting of the SWEEP TIME/CM control. This free-running trace is useful as a base line from which to make dc measurements when the input signal is dc coupled.

Magnification of the Sweep

Any part of the trace may be expanded horizontally by as much as 50 times through the use of the SWEEP MAGNIFIED portion of the HORIZONTAL DISPLAY switch. To expand a given portion of the sweep, first set that portion to the center of the graticule by means of the HORIZONTAL POSITION control. Then set the HORIZONTAL DISPLAY switch to the desired degree of magnification.

In magnified sweep operation, the sweep rate is multiplied by the setting of the HORIZONTAL DISPLAY switch. This means that the SWEEP TIME/CM setting must actually be divided by the setting of the HORIZONTAL DISPLAY switch to obtain the correct time for the sweep to move one centimeter. For example, if the SWEEP TIME/CM is set to 5 μSEC and the HORIZONTAL DISPLAY switch is set to X10, the true sweep rate is 0.5 microsecond or 500 nanoseconds per centimeter.

It should be noted that with combinations of the SWEEP TIME/CM control and the HORIZONTAL DISPLAY switch which produce sweep rates faster than about 0.1 microsecond per centimeter, the calculated sweep rates should not be depended upon to be accurate enough to base time measurements on them.

X-Y MODE OF OPERATION

Placing the HORIZONTAL DISPLAY switch in the HORIZ. AMPLIFIER position sets the Type 503 Oscilloscope up for X-Y operation. In this mode of operation, input signals are applied to both the horizontal and vertical amplifiers, and the display is a graph of the waveform on one channel versus the waveform on the other channel. The horizontal sweep is disabled. Examples of the use of the X-Y mode of operation are the plotting of hysteresis loops, of voltage across a semiconductor versus current through it, and of force or pressure versus deformation or strain in a material. Use can still be made of the differential input feature on one or both channels.

APPLICATIONS

The following paragraphs describe procedures for making measurements of voltage, elapsed-time, and phase-shift with the Type 503 Oscilloscope. No attempt has been made to describe any but the most basic techniques. Familiarity with the instrument will enable the operator to apply the essence of these techniques to a wide variety of applications, depending upon the problem at hand.

Voltage Measurements

To measure the ac component of a signal, proceed as follows:

1. Display the waveform over as large a portion of the screen as possible by adjusting the appropriate SENSITIVITY control.

2. With the aid of the graticule, measure the distance (in centimeters) between the two points on the waveform between which the voltage measurement is desired. This will be a vertical measurement where the waveform to be measured is applied to the vertical channel, a horizontal measurement where the waveform to be measured is applied to the horizontal channel. Make sure that the appropriate VARIABLE control is in the CALIBRATED position. On small voltage measurements, the width of the trace can make up an appreciable part of the entire measurement. For this reason, it is important to take all readings in a given measurement from the same side of the trace.

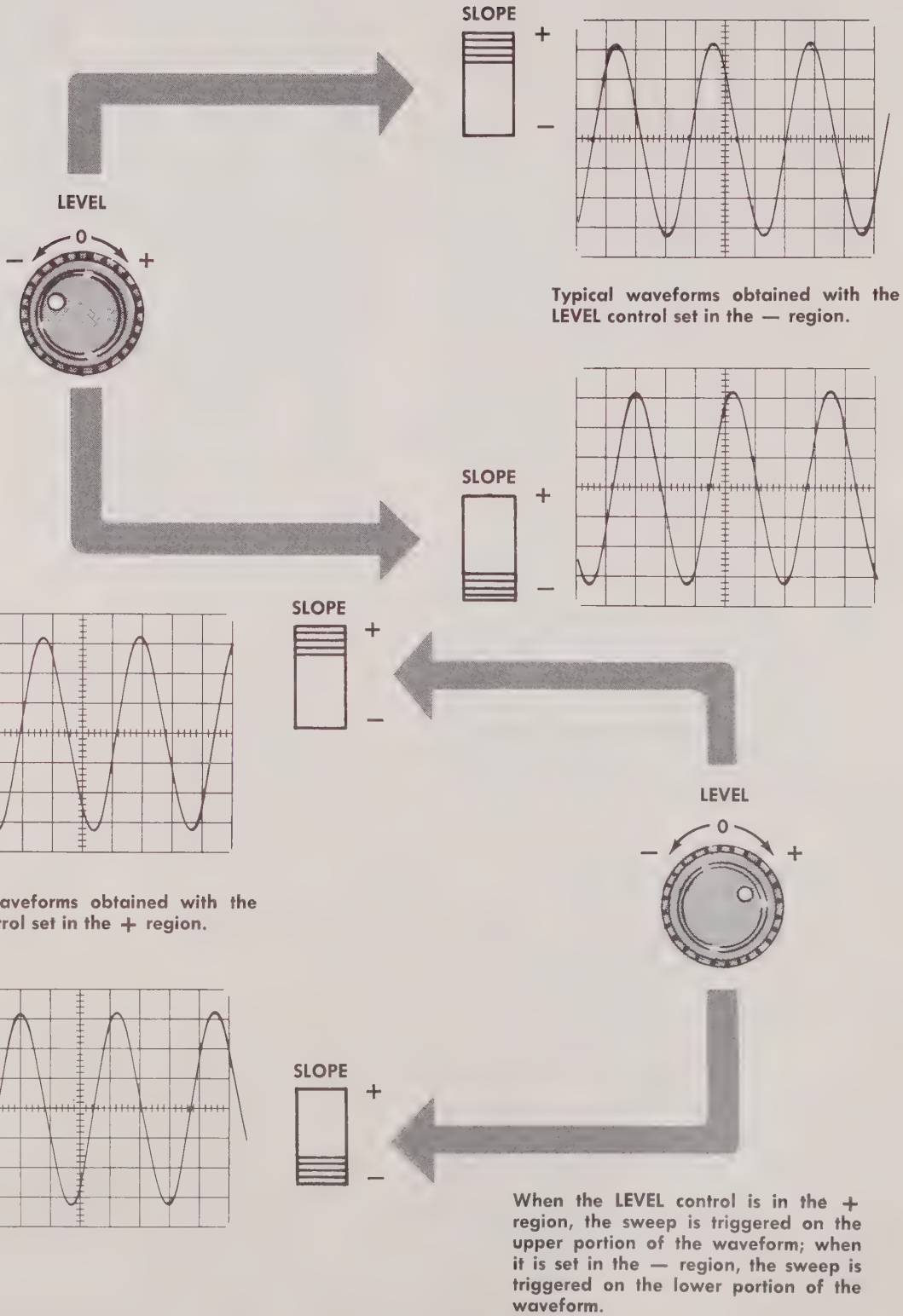

SLOPE
+
–
LEVEL
0
– +
Typical waveforms obtained with the LEVEL control set in the — region.
SLOPE
+
–
SLOPE
+
–
Typical waveforms obtained with the LEVEL control set in the + region.
LEVEL
0
– +
SLOPE
+
–
When the LEVEL control is in the + region, the sweep is triggered on the upper portion of the waveform; when it is set in the — region, the sweep is triggered on the lower portion of the waveform.

Fig. 3-4. Effects of the LEVEL control and SLOPE switch.

3. Multiply the distance between the two points by the setting of appropriate SENSITIVITY control and by the attenuation factor, if any, of the probe. This is the voltage between the two points on the waveform.

To measure the dc level at some point on a signal, proceed as follows:

1. Set the INPUT switch associated with the INPUT connector to which the signal is connected to the GND position.

2. If the horizontal sweep is being used, rotate the LEVEL control fully clockwise to the FREE RUN position to produce a free-running trace. If the oscilloscope is being used in the X-Y mode of operation, the signal on the other channel will produce a trace.

3. With the appropriate POSITION control, position the trace so that it lies along one of the lines of the graticule. This line will be used as a ground reference line; its position in any given case will depend upon the polarity and amplitude of the input signal to be measured. Do not adjust this POSITION control after the reference line has been established.

4. Set the INPUT switch mentioned in step 1 to the DC position. If the horizontal sweep is being used, adjust the LEVEL control for a stable display.

5. Measure the distance, in centimeters, from the ground reference line established in step 3 to the point at which the dc voltage level is desired.

6. Multiply this distance by the setting of the appropriate SENSITIVITY control and the attenuation factor, if any, of the probe. This is the dc level of the point measured.

Time and Frequency Measurements

To measure the time interval between two points on a waveform, proceed as follows:

1. Set the oscilloscope up for conventional operation with the signal applied to either of the vertical INPUT connectors.

2. With the aid of the graticule, measure the horizontal distance, in centimeters, between the two points whose interval you wish to find. Make sure that the SWEEP TIME/CM VARIABLE control is in the CALIBRATED position.

3. Multiply the distance measured by the setting of the SWEEP TIME/CM control and divide by the setting of the HORIZONTAL DISPLAY switch (X1, X2, X5, etc.). This is the time interval between the two points measured.

To determine the frequency of a recurrent waveform, simply take the reciprocal of the time interval between corresponding points on two consecutive cycles of the waveform.

Phase-Shift Measurements

To measure the phase shift produced in a given signal by some device, proceed as follows:

1. Set the oscilloscope up for conventional externally triggered operation with the signal at the input to the phase-shifting device applied to either of the vertical INPUT connectors.

2. Horizontally position the display so that an easily identifiable point of a cycle corresponds to one of the vertical graticule lines.

3. Without making any adjustments to the oscilloscope, move the signal probe from the input to the output of the device under test. You will find that the display has shifted horizontally.

4. Measure the amount of horizontal shift of the display in centimeters.

5. Measure the distance in centimeters between corresponding points on two consecutive cycles of the waveform.

6. Divide the measurement obtained in step 4 by the measurement obtained in step 5 and multiply the result by 360°. This is the phase shift produced in the signal by the device under test.

A second method for comparing the phase relationship of two signals of the same frequency makes use of the X-Y mode of operation. This method is suitable only when comparing two sine waves.

1. Apply the sine waves to the two +INPUT connectors. The display will be an ellipse. (Actually, the display will appear as a diagonal straight line if the two sine waves are in phase or exactly 180° out of phase, or it will appear as a circle if the two sine waves are exactly 90° or 270° out of phase. Application of these instructions, however, will still apply.)

2. Center the ellipse horizontally and vertically on the crt screen.

3. Measure the distances A and B on the display as shown in Figure 3-5.

A/B is equal to the sine of the phase difference between the two signals.

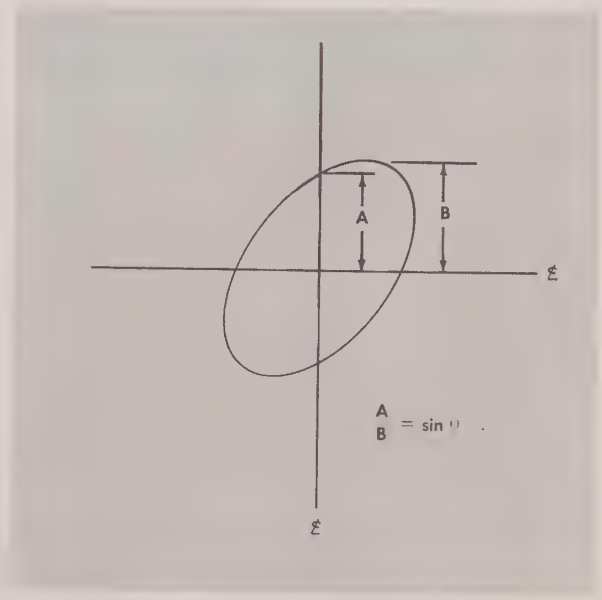


Fig. 3-5. X-Y method of calculating phase difference (θ) of two sine waves.

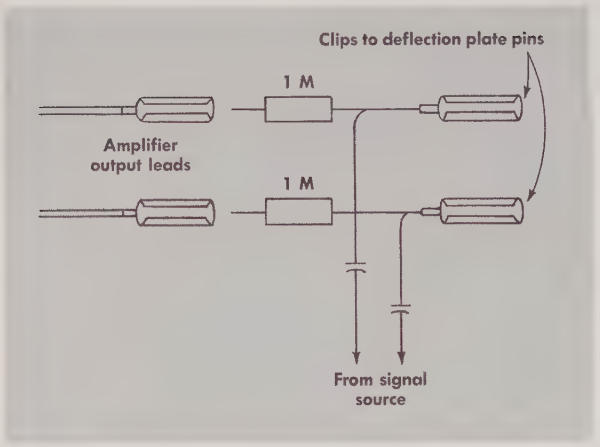


Fig. 3-6. Typical circuit for ac coupling to the crt deflection plates.

Direct Connection to the CRT Plates

In some applications it may be desirable to connect a signal directly to one or both sets of crt deflection plates, bypassing the internal oscilloscope amplifiers. The vertical deflection plate pins are located on the side of the neck of the crt, and the horizontal deflection plate pins are located at the bottom of the neck of the crt.

With a signal connected directly to the crt pins, it is possible, under optimum impedance matching conditions and with connections kept as short as possible, to obtain a bandwidth on the order of 100 mc with the Type 503. However, limitations of the sweep magnifier at the faster sweep rates discussed earlier in this section must be kept in mind when making risetime measurements on fast-rise waveforms. The vertical and horizontal deflection factors of the crt are approximately 22 volts per centimeter and 18 volts per centimeter, respectively.

The diagram in Fig. 3-6 shows how a signal may be ac coupled to the crt deflection plates. This method of ac coupling permits the use of front panel controls to position the display on the screen. The SENSITIVITY control of the bypassed amplifier should be placed in the 20 VOLTS/CM position, and both INPUT switches should be placed in the GND position. The value of the capacitors shown in Fig. 3-6 will depend upon the characteristics of the signal to be displayed.

To dc couple a signal to the deflection plates, remove the amplifier leads and connect the signal directly to the crt pins. It is a good idea to tape the ends of the loose amplifier leads to prevent accidental shocks to operating personnel. For best performance, the average of the voltages at the two plates must be kept close to +150 volts; otherwise, the display will be defocused and slightly bowed, and the sweep rate, if the sweep is used, will not be accurate. Actually, if these effects can be tolerated, it is possible to have both plates in the vicinity of ground and still obtain a useful display. Typically, the sweep rate is about 8% slow when a ground level signal is connected to the vertical deflection pins.

Care should be exercised in connecting and disconnecting the crt pin leads as the pins can be easily bent or broken.

USE OF PROBES

Use of an attenuator probe with the Type 503 will reduce the capacitive and resistive loading on a circuit under test, but at the same time will also reduce the sensitivity.

Connected to an input connector of the Type 503, a Tektronix probe presents a characteristic input impedance of 10 megohms paralleled by from 8 to 14 $\mu\mu$f (depending on the probe) and has an attenuation of 10:1. The maximum voltage rating of a Tektronix probe is 600 volts. Exceeding this rating, either in dc volts or peak ac volts, may damage the probe.

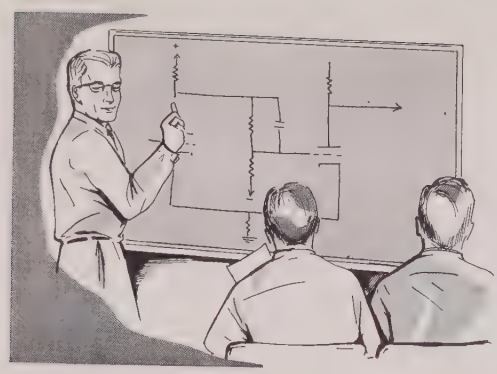
When making amplitude measurements with an attenuator probe, be sure to multiply the observed amplitude on the crt by the attenuation factor of the probe. If the waveform being displayed contains fast-changing signals, it will generally be necessary to clip the probe ground lead to the chassis of the equipment under test.

Probe Compensation

An adjustable capacitor in all Tektronix probes is used to compensate for variations in input capacitance from one instrument to another, or between two input connectors of one instrument. To insure the accuracy of pulse and transient measurements always check the compensation before using a probe. To check or adjust the probe compensation, display several cycles of the Calibrator waveform on the crt by connecting a test lead between the 500 mV CAL. OUT connector and the VERTICAL +INPUT connector. For this display set the VERTICAL SENSITIVITY control to .1 VOLTS/CM, the +INPUT switch to DC, and the —INPUT switch to GND.

Carefully observe the waveform display on the crt, and particularly note the general shape of the leading corner of each positive pulse. Then disconnect the test lead between the CAL. OUT and +INPUT connectors, and connect the probe to the +INPUT connector. Set the VERTICAL SENSITIVITY control to 10 mV/CM and touch the probe tip to the 500 mV CAL. OUT connector. Square waves having the same amplitude as the previous display should now appear on the crt. Carefully adjust the probe capacitance, if necessary, until the leading corners of the positive pulses have the same shape as those in the previous display.

To compensate the probe on the horizontal channel, a sawtooth sweep voltage must be applied to the vertical channel to obtain a vertical display of the calibrator waveform. The displayed waveform will then appear somewhat similar to that shown in Fig. 6-5. However, if both the horizontal and vertical input capacitances are adjusted correctly (47 $\mu\mu$f), a probe compensated on the vertical channel will function properly on the horizontal channel. The procedure for checking the input capacitance is given in Section 6 under "High Frequency Compensation".



SECTION 4

CIRCUIT DESCRIPTION

NOTE

Throughout this section of the manual, you should refer to the circuit diagrams contained in the Parts List and Schematic Diagrams booklet which accompanies this manual.

VERTICAL AMPLIFIER

General Description

The Vertical Amplifier consists of two opposing input circuits and two dc-coupled, push-pull amplifiers. The maximum overall gain of the Vertical Amplifier is on the order of 25,000, which provides the required 25 volts per centimeter of deflection at the crt from each millivolt of signal at the inputs (with the SENSITIVITY control in the 1 mV/CM position).

The Input Amplifier consists of two stages, a cathode-coupled paraphase amplifier stage and a pair of transistors. The combined gain of the two stages is controlled by negative feedback. The output from the Input Amplifier drives the Output Amplifier which, in turn, drives the crt deflection plates. Changes in Vertical Amplifier sensitivity are accomplished by input attenuation and by negative feedback in the Input Amplifier. Vernier attenuation is accomplished by degeneration in the cathode circuit of the Output Amplifier.

Input Circuits

The two input circuits allow the Input Amplifier to be operated either as a single-ended cathode-coupled paraphase amplifier or as a differential amplifier. For single-ended operation, the signal is applied to one of the two input connectors and the other is grounded. For differential operation, signals are applied to both input connectors and the amplifier amplifies the difference between them. The two input switches permit both inputs to be either ac or dc coupled, or one ac coupled and the other dc coupled. The lower bandpass limit of the inputs when ac coupled is is about 7.5 cps.

In the 1 mV/CM to .2 VOLTS/CM positions of the SENSITIVITY control, the signal is applied "straight through" to the grid circuit, or circuits, of the Input Amplifier; the changes in sensitivity are accomplished by changes in negative feedback within the amplifier. In the .5 VOLTS/CM to 2 VOLTS/CM positions of the SENSITIVITY control, a X10 attenuator is inserted in the input circuits and the negative feedback values of the 1 mV/CM to .2 VOLTS/CM positions are repeated. In the 5 VOLTS/CM to 20 VOLTS/CM positions, a X100 attenuator is inserted in the input circuits and the negative feedback values are repeated again.

The attenuators are both resistance and capacitance dividers. For dc and low frequency signals, the attenuators act purely as resistance dividers, since the impedance of the capacitors is so high that it can be neglected. For higher frequency signals, however, the impedance of the capacitors is less, and their effect on the circuit is more pronounced. Near the upper-frequency range of the amplifier, the impedance of the capacitors becomes so low, compared to the resistance of the circuit, that the attenuators become capacitance dividers.

In addition to providing the proper degree of attenuation, the resistance values of the attenuators are chosen so as to provide a constant 1-M input resistance, regardless of the setting of the SENSITIVITY control. The capacitance of the attenuators is also adjusted to provide a constant input capacitance of 47 $\mu\mu$f regardless of the setting of the SENSITIVITY control.

Input Amplifier

The Input Amplifier amplifies the potential difference between the two grids of V434. When one grid goes positive and the other goes negative with respect to ground, the output of the stage is proportional to the sum of the amplitudes of the two signals. When both grids go positive or both go negative, the output is proportional to the difference between the amplitudes of the two signals. In single-ended operation, a signal is applied to one grid while the other grid circuit is grounded; therefore, the output is proportional to the amplitude of the one signal applied. The output of V434, then, is a push-pull signal to the bases of the transistors, Q454 and Q464, regardless of whether the Input Amplifier is being operated single-ended or differentially.

The gain of the Input Amplifier is varied (in steps) by changing the value of R408. This varies the amount of negative feedback applied to the cathode circuit of the first stage from the output of the second. This feedback is applied through R457 and R467 to the parallel network of R419 and L419 (in series) and R408. As the value of R408 is increased, the amount of negative feedback voltage is increased, limiting the gain of the amplifier.

Dc balance of the Vertical Amplifier is accomplished by means of the COARSE DC BAL. (VERT.) control and the DC BAL. control. Proper adjustment of these two controls sets the two ends of R408 at the same potential so that there is no current flowing through it. This provides vertical stability of the trace throughout the range of the SENSITIVITY control.

The second stage of the Input Amplifier is provided with a positive feedback path from the collector of each side to the base of the other. This positive feedback path is adjusted, by varying the value of R460, to set this second stage for infinite gain. Thus, the second stage provides its own driving current and none is diverted from the plate circuits of the first stage. The negative feedback through the first stage of the amplifier prevents the infinite-gain second stage from oscillating. The effect of R460 is most pronounced in the 1 mV/CM position of the SENSITIVITY control since there is the least amount of overall negative feedback in this position.

Output Amplifier

The Output Amplifier is the stage that drives the vertical deflection plates of the crt. The gain of this stage can be adjusted by means of the .2V GAIN. ADJ. (VERT), R478, and the VARIABLE control, R488.

Vertical positioning of the crt beam is accomplished by means of the cross-coupled dual POSITION control, R470. Adjustment of this control varies the current through the Output Amplifier tubes thereby changing the average dc voltage at each of the plates inversely to the other. At the same time, through feedback in the Input Amplifier, the control also produces a small push-pull change in voltage at the grids of the Output Amplifier to maintain the cathodes at the same potential as the current is changed.

Trigger Pickoff

The output from V474, one side of the Output Amplifier, is applied through a divider network made up of R490, R491, and R492 to the SOURCE switch, SW5. Thus, when the SOURCE switch is in the INT. position, the output of the Output Amplifier is applied to the Sweep Trigger to start the Horizontal sweep.

HORIZONTAL AMPLIFIER

X-Y Operation

When the Type 503 Oscilloscope is set for X-Y operation (HORIZONTAL DISPLAY switch in the HORIZ. AMPLIFIER position), the Horizontal Amplifier is virtually identical to the Vertical Amplifier. A given signal or signals applied to the Horizontal Amplifier inputs will produce the same deflection as the same signal or signals applied to the Vertical Amplifier inputs, except, of course, that the deflection will be in the X (horizontal) plane rather than the Y (vertical) plane. This mode is used for plotting two voltage functions against one another.

Sweep Operation

When the Type 503 Oscilloscope is set up for sweep operation, the Horizontal Amplifier is used to amplify the sawtooth waveform from the Sweep Generator. In this mode of operation the Horizontal Input Amplifier is connected for single-ended operation. The sawtooth waveform is applied to one grid of the Input Amplifier and the other grid is grounded. Neither of the input attenuators is used.

The feedback circuits which control the gain of the Horizontal Amplifier operate in the same manner for sweep operation as for X-Y operation, except that a different set of resistors is used in the Input Amplifier cathode circuit. Also the VARIABLE control in the cathode circuit of the Output Amplifier is shorted out. In sweep operation, the POSITION control varies the dc potential on the active grid of the Input Amplifier rather than the current through the two halves of the Output Amplifier.

SWEEP TRIGGER

The Sweep Trigger circuit consists of the Trigger Input Amplifier, V24, and the Trigger Multivibrator, V45. The Trigger Input Amplifier amplifies (and, when desired, inverts) the incoming triggering signal and applies it to the input of the Trigger Multivibrator. The Trigger Multivibrator produces a negative-going rectangular pulse whose leading edge is coincident with the point on the triggering signal at which it is desired to start the horizontal sweep. This leading edge is then differentiated to produce a sharp negative spike which triggers the Sweep Generator.

Trigger Source

The triggering signal from which the rectangular output pulse is produced may be obtained from any one of three sources. When the SOURCE switch is in the INT. position, the signal is obtained from the Trigger Pickoff circuit of the Vertical Amplifier. When the SOURCE switch is in the EXT. position, the signal may be obtained from an external source through the EXTERNAL TRIG. IN connector on the front panel. When the SOURCE switch is in the LINE position, the signal is obtained from one side of the 6.3-volt ac filament heater circuit.

Trigger Slope

The negative-going pulse is initiated at the output of the Trigger Multivibrator (plate of V45B) only when there is a negative-going signal at the input of the Trigger Multivibrator (grid of V45A). However, it is desired to be able to start the sweep during either a positive-going or negative-going portion of the triggering signal. Therefore, some provision must be made for choosing between inverting or not inverting the triggering signal in the Trigger Input Amplifier. This is done by means of the SLOPE switch.

With the SLOPE switch in the — position, V24 is a cathode-coupled amplifier and the triggering signal is applied to the grid of V24A. The signal at the plate of V24B is in phase with the incoming triggering signal. Thus, the negative-going portion of the signal at the input to the Trigger Multivibrator corresponds to the negative-going portion of the incoming triggering signal. With the SLOPE switch in the + position, the triggering signal is applied to the grid of V24B, and V24B becomes an ordinary plate-loaded amplifier. The signal at the plate of V24B is opposite in polarity from the incoming triggering signal. Thus, the nega-

tive-going portion of the signal at the input to the Trigger Multivibrator corresponds to the positive-going portion of the incoming triggering signal.

Trigger Level

The LEVEL control, R17, varies the bias on the tube to which it is connected. This in turn varies the quiescent voltage at the plate of V24B about which the signal varies. Since the Trigger Multivibrator is triggered at a given dc level, varying the dc voltage about which the triggering signal varies in effect varies the instantaneous voltage level of the signal at which the Trigger Multivibrator is triggered. Thus, through the use of the SLOPE and LEVEL switches it is possible to trigger the Trigger Multivibrator at virtually any point on either a positive-going or negative-going portion of the triggering signal.

Trigger Multivibrator

The Trigger Multivibrator operates as follows. In the quiescent state, that is, ready to receive a signal, V45A is conducting and its plate voltage is down. This holds the grid of V45B below cutoff, since the two circuits are dc-coupled. With V45B in a state of cutoff, its plate voltage is up.

The negative-going portion of the signal from the Trigger Amplifier drives the grid of V45A in a negative direction, and the cathodes of both tubes follow the grid down. At the same time the plate voltage of V45A starts to rise. This causes the grid voltage of V45B to rise. With the grid of V45B going up and its cathode going down, V45B starts to conduct. As V45B starts conducting, its cathode starts going up, taking the cathode of V45A up with it. With the grid of V45A down and its cathode up, V45A cuts off. This causes the plate of V45A, and therefore the grid of V45B, to go farther in a positive direction, and causes V45B to conduct heavily. This creates a negative step at the plate of V45B. The transition occurs very rapidly, regardless of how slowly the signal at the grid of V45A falls initially.

When the signal at the grid of V45A goes in the positive direction, just the opposite chain of events will occur. V45A will start conducting again, and V45B will cut off. The result is a positive step at the plate of V45B. This step is also differentiated to form a positive spike but this spike is bypassed to the +250-volt supply by D44 and is not used.

Automatic Triggering

When the LEVEL control is turned fully counterclockwise, the AUTOMATIC switch, SW17, is activated and converts the Trigger Multivibrator from a bi-stable configuration to an astable (free-running) configuration. (This should not be confused with the action of the FREE RUN switch, shown on the Sweep Generator diagram, which causes the Sweep Generator to free-run.) This is accomplished by coupling the grid circuit of V45B to the grid circuit of V45A via R40. In addition, the dc coupling between the Trigger Input Amplifier and the Trigger Multivibrator is removed when the switch is in this position.

To understand the operation of the Trigger Multivibrator in the free-running mode of operation, first assume that V45B is cut off and V45A is just being driven into cutoff by the charge on C31. The voltage at the plate of V45A starts to rise, carrying with it the voltage at the grid of V45B. So V45B starts to conduct causing a negative step at its plate. Since the two grids are coupled through R40, the grid of V45A will start moving positively at the same time as does the grid of V45B. However, the time constant of the R40-C31 network is such that it takes about 0.01 second for the voltage at the grid of V45A to rise exponentially from its starting point, below cutoff, to a point where the tube will start conducting.

When V45A does start conducting, its plate voltage will drop, carrying with it the grid of V45B. V45B will cut off, causing a positive step at its plate. At the same time that the grid of V45B goes negative, the grid of V45A will also start negative. Once again, it will take about 0.01 second for C31 to charge up sufficiently to cut V45A off. When V45A does cut off, the cycle starts over.

Hence, in the absence of a triggering signal, the Trigger Multivibrator free-runs at about 50 cps. However, since the triggering signals from the Trigger Input Amplifier are still coupled to the Trigger Multivibrator through C31, any triggering signal over 50 cps in frequency will produce synchronized operation of the Trigger Multivibrator. The 50-cps free running sweep produced in the absence of a triggering signal provides a base line from which to make voltage measurements and also indicates that the instrument is adjusted to display any signal that might be applied to the input.

SWEEP GENERATOR

The Sweep Generator, upon receipt of a trigger pulse from the Sweep Trigger, produces a linearly rising (sawtooth) voltage which is applied through the Horizontal Amplifier to the crt deflection plates. This causes the spot to move from left to right on the crt screen and form the sweep. The amplitude of the sawtooth voltage is about 100 volts. Its rate of rise is controlled by the values of the Timing Capacitor and Timing Resistor switched into the circuit by the SWEEP TIME/CM switch on the front panel.

The Sweep Generator consists of three main circuits; the Sweep-Gating Multivibrator, the Miller Runup Circuit, and the Hold-Off Circuit. The Sweep-Gating Multivibrator consists of V135A, V135B, and V145A. The essential components of the Miller Runup Circuit are: the Miller Runup Tube, V160A; the Runup Cathode Follower, V160B; the Disconnect Diodes, V152A and V152B; the Timing Capacitor, C160; and the Timing Resistor, R160. The Hold-Off Circuit consists of the Hold-Off Diode, V152C; the Hold-Off Cathode Follower, V145B; the Hold-Off Resistor, R181; and the Hold-Off Capacitor, C160 (the Hold-Off Circuit makes use of some of the same timing capacitors as the Miller Runup Circuit).

In the quiescent state, that is, when no sweep is being generated, V135A is conducting and V145A is cut off. The plate of V145A is at about —2.5 volts with respect to ground. The Disconnect Diodes are conducting and hold both sides of the Timing Capacitor at about —2.5 volts. With its cathode grounded and its grid at —2.5 volts, V160A is conducting heavily and its plate is at about +30 volts.

Sweep Generation

A negative trigger pulse, arriving at the grid of V135A from the Sweep Trigger circuit, causes the Sweep-Gating Multivibrator to switch rapidly to its other state. That is, V135A cuts off and V145A conducts. As V145A conducts, its plate voltage goes down, cutting off the Disconnect Diodes. When the Disconnect Diodes cut off, the plates of the Timing Capacitor are no longer held at —2.5 volts, and the Timing Capacitor starts to charge toward the instantaneous potential difference between the —100-volt supply and the potential on the cathode of V160B. However, as the lower plate of the Timing Capacitor starts to move in a negative direction, it takes the grid of V160A with it. This produces a positive swing at the plate of V160A which is coupled, through B167 and V160B, to the upper plate of the Timing Capacitor. This increases the voltage to which the Timing Capacitor is trying to charge. The effect is to "straighten out" the charging curve by increasing the charging voltage with each increment of charge on the capacitor. The positive voltage swing on the upper plate of the Timing capacitor also tends to prevent the lower plate from swinging negatively. Since the gain of V160A is about 200, the potential on the upper plate moves about 100 volts with respect to ground while the potential on the lower plate moves about one-half volt. The result is an extremely linear ramp at the cathode of V160B, which is applied through the Horizontal Amplifier to the horizontal deflection plates of the crt.

Sweep Length

The length of the sweep, that is, the distance the spot moves across the crt, is determined by the setting of the SWP. LENGTH control, R176. As the sweep voltage rises linearly at the cathode of V160B, there will be a linear rise in the voltage at the wiper arm of the SWP. LENGTH control. This will increase the voltage at the plate, and therefore the cathode, of V152C and at the grid and cathode of V145B. As the voltage at the cathode of V145B rises, the voltage at the grid of V135A will rise. When the voltage at this point rises to a point where V135A comes out of cutoff, the Sweep-Gating Multivibrator will rapidly revert to its original state with V135A conducting and V145A cut off. The voltage at the plate of V145A will then rise, carrying with it the voltage at the plates of the Disconnect Diodes.

V152B starts conducting, and brings the grid of V160A quickly back up to its quiescent level. The rise in voltage at the grid causes the tube to conduct more, so the plate voltage drops, carrying with it the grid and cathode of V160B. When the voltage at the cathode of V160B returns to about —2.5 volts, V152A conducts, clamping the voltage at this point. The circuit has now returned to its quiescent level and is ready for the next trigger.

Hold-Off

The Hold-Off Circuit prevents the Sweep Generator from being triggered during the sweep retrace interval. It does this by holding the grid of V135A positive enough to keep V135A in conduction until after the Miller Runup Circuit has stabilized in the quiescent condition.

Under quiescent conditions, normal conduction through V152C allows the Hold-Off Capacitor, C160, to be charged to about 70 volts. During the latter part of the sweep, the rising voltage at the cathode of V152C discharges this capacitor to a lower voltage, in the vicinity of about 55 volts. At the end of the sweep, when the voltage at the cathode of V160B drops, the voltage at the SWP. LENGTH wiper arm also drops and V152C cuts off. The cathode tries to follow the drop in voltage at the plate but is held up by the charge on the Hold-Off Capacitor. The Hold-Off Capacitor charges again exponentially toward 100 volts, carrying the cathode of V152C and the grid of V145B negative. The cathode of V145B, and therefore the grid of V135A, follows the grid of V145B. At some point in this exponential charging curve, depending upon the settings of the STABILITY ADJUST control and the FREE RUN switch, the grid of V135A will become negative enough that a negative trigger pulse coming from the Sweep Trigger circuit can again take V135A into cutoff.

The hold-off time, then, is determined by the value of C160 switched into the Hold-Off Circuit by the SWEEP TIME/CM switch. The amount of hold-off time required is determined by the sweep speed. For this reason the SWEEP TIME/CM switch changes the amount of capacitance in the Hold-Off Circuit simultaneously with that in the Timing Circuit.

Sweep Stability

The STABILITY ADJUST control, R111, regulates the dc level at the grid of V135A. This control is adjusted so that the voltage at the grid of V135A is just high enough to prevent the circuit from free running. When it is adjusted in this manner, a sweep can be produced only when a negative trigger pulse from the Sweep Trigger can drive V135A into cutoff. Turning the LEVEL switch fully clockwise closes the FREE RUN switch and shorts out R111. This places a more negative voltage on the grid of V135A such that V135A cuts off immediately upon decay of the hold-off voltage, at which time the next sweep is initiated. The result is a free-running sweep whose period is the total of the sweep time plus the hold-off time at any given setting of the SWEEP TIME/CM switch. (This is compared to a maximum repetition rate of about 50 cps when the LEVEL switch is turned fully counterclockwise to the AUTO. position).

Unblanking

The positive rectangular pulse appearing at the cathode of V135B during sweep time is applied as an unblanking pulse to the crt. Action of this pulse is discussed under the description of the crt circuit later in this section. It should be noted that, when the HORIZONTAL DISPLAY switch is in the HORIZ. AMPLIFIER position, the Sweep-Gating Multivibrator is disabled, and there is no current flowing through V135A or V145A. Therefore, the cathode of V135B is held at +225 volts and the crt is continuously unblanked.

CRT CIRCUIT

The crt in the Type 503 oscilloscope makes use of an extra set of deflection plates for unblanking during sweep time. One of these plates has a fixed potential of about +225 volts on it; the other is tied to the cathode of V135B in the Time-Base Generator. Quiescently, this latter plate is held at a relatively low potential, in the vicinity of +80 volts. Therefore, the electron beam in the crt is deflected and absorbed by the +225-volt plate; none of it reaches the screen. During sweep time, however, the unblanking pulse from V135B raises the potential of the second plate from +80 volts to about +225 volts. When this happens, both unblanking deflection plates attract the electron beam in the same amount with the net result that the beam is not deflected toward either plate, but passes on through to the crt screen.

The INTENSITY control varies the control grid of the crt from about —20 volts to —150 volts with respect to the cathode. Connections are provided on the rear of the oscilloscope cabinet to couple an ac signal to the control grid to provide intensity modulation of the trace if desired.

CALIBRATOR

The calibrator provides a 500-millivolt square wave and a 5-millivolt square wave for use in calibrating the gain of the Horizontal and Vertical Amplifiers. The two amplitudes are obtained by tapping off at different points in a voltage divider network.

The square wave is produced by the turning off and on of B886. This is accomplished by the combined action of B886, B883, and C883. B886 and B883 are neon tubes which nominally drop about 60 volts when they are conducting. However, if they are not conducting, they require about 80 volts across them to start conduction.

During the time that B886 is turned off, B883 is conducting. This causes C883 to discharge which allows both plates of B883 to move in a positive direction (60 volts apart). When the common connection at the top of the two neon tubes reaches a potential of about +80 volts with respect to ground, B886 conducts. The current through R886 and R887 produces a 0.5-volt drop across them and the voltage at the upper end of B886 is, therefore, about +60.5 volts with respect to ground. Since the upper plate of C883 is now at about +20 volts with respect to ground, the potential across B883 is only about 40 volts, and B883 stops conducting. With no current through B883 to maintain the charge on C883, the upper plate of C883 starts to move in a negative direction. The upper end of B883 is held steady at +60.5 volts by the drop across B886, R886, and R887, so when the upper plate of C883 becomes —20 volts with respect to ground, B883 conducts. This drops the voltage at the upper end of the two neon tubes to +40 volts, and B886 cuts off, completing one cycle of the square wave.

It should be noted that the potentials mentioned in the foregoing discussion (except the drop across R886 and R887) are typical nominals only, and may vary considerably among different units. The only effect will be a slight variation in the frequency and symmetry of the output waveform.

The CAL. ADJ. control, R880, provides a means of adjusting the voltage drop across R886 and R887 by controlling the current through them.

POWER SUPPLY

T601 provides filament power for the graticule lights and all of the tubes, except the first stage of the Input Amplifier, and B+ voltage (about 500 volts) for the power supply oscillator tube, V620. The rest of the voltages used in the oscilloscope are provided by the secondary of T620.

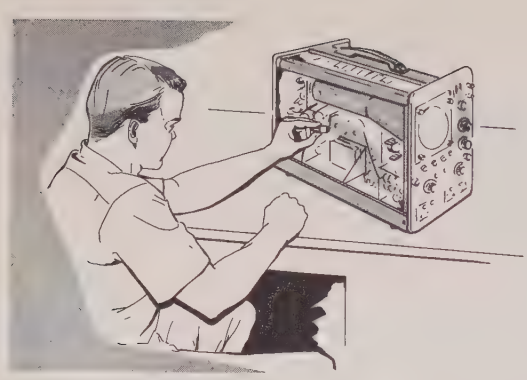
V620, the primary of T620, and part of the secondary of T620 form an Armstrong oscillator circuit to drive T620 at about 25 kc. Each of the outputs of the secondary of T620 bears a fixed turns ratio to the others such that a change in one effects a proportional change in each of the others. Adjustment and regulation of all of the output voltages, then, are accomplished through adjustment and regulation of just one output, the —100 volt output. This, in turn, is referenced to the 85-volt drop across the voltage regulator tube, V659.

Adjustment of the output voltages is accomplished by means of the —100 V ADJ. control as follows. Moving the wiper arm of the —100 V ADJ. control in a positive direction reduces the bias on V634B. This, in turn, lowers the voltage at the plate of V634B and, therefore, at the grid of V634A. This causes an increase in voltage at the plate of V634A which, in turn, increases the screen voltage of V620. Increasing the screen voltage of V620 increases the G_m, and therefore the gain, of the tube, and thereby increases the amplitude of oscillations in the secondary of T620. This results in greater output from all of the supplies.

Regulation is accomplished in virtually the same manner. A lowering of the source voltage to which the oscilloscope is connected, or a lowering of any of the output voltages due to loading, causes the volts per turn in the secondary of T620 to decrease. This causes the —100-volt supply to drop (move positively) with the resulting rise in the grid voltage of V634B. This results, as before, in a rise in the screen voltage of V620 and an increase in the amplitude of oscillations, bringing the power supply outputs back to their nominal values.

An increase in any of the output voltages, whatever the reason, has the opposite effect on the screen voltage of V620 and decreases the amplitude of oscillations in T620.

Regulation of the power supply outputs will be accomplished as long as the source voltage remains between 105 and 125 for 117-volt operation, or between 210 volts and 250 volts for 234-volt operation.



SECTION 5

MAINTENANCE

Preliminary Instructions

PREVENTIVE MAINTENANCE

Visual Inspection

Every few months, the oscilloscope should be visually inspected so that possible circuit defects may be detected. These defects may include such things as loose or broken connections, damaged binding posts, improperly seated tubes, scorched wires or resistors, missing tube shields, and broken terminal strips. For most visual troubles the remedy is apparent; however, particular care must be taken when heat-damaged components are detected. Overheating of parts is often the result of other, less apparent, defects in the circuit. It is essential to determine the cause of overheating, before replacing heat-damaged parts, in order to prevent further damage.

Calibration

The Type 503 Oscilloscope is a stable instrument which should provide many hours of trouble-free operation. However, to insure the reliability of measurements we suggest that you calibrate the instrument after each 500 hours of operation (or every six months if used intermittently). A complete step-by-step procedure for calibrating the instrument is presented in the Calibration section of this manual.

REMOVAL AND REPLACEMENT OF PARTS

General Information

Procedures required for replacement of most parts in the Type 503 Oscilloscope are obvious. Detailed instructions for their removal are therefore not required. Other parts, however, can best be removed if a definite procedure is followed. Instructions for the removal of some of these parts are contained in the following paragraphs. Because of the nature of the instrument, replacement of certain parts will require recalibration of sections of the oscilloscope to insure proper operation. Refer to the Calibration section of this manual.

Removal of Panels

The panels of the Type 503 Oscilloscope are held in place by small screwhead fasteners. To remove the side panels, use a screwdriver to rotate the fasteners approximately two turns counterclockwise; then pull the upper portion of the panels outward from the carrying handles (see Fig. 5-1). Panels are replaced by reversing the order of their removal.

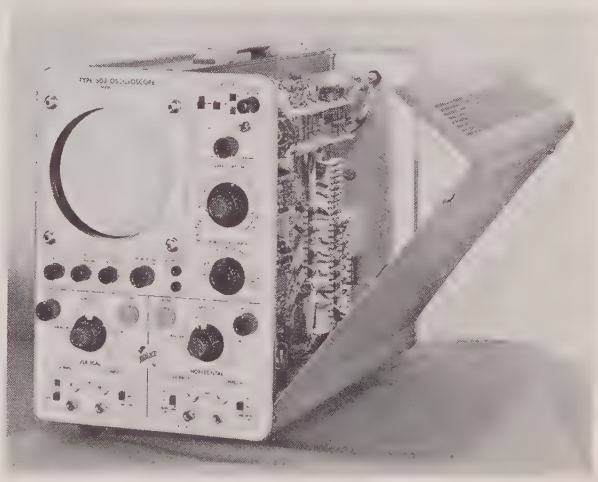


Fig. 5-1. Removing the oscilloscope side panels.

Replacement of the Cathode-Ray Tube

To remove the cathode-ray tube, first disconnect the tube socket and all leads connected to the neck of the tube. Remove the graticule cover, spacer washers, graticule, and graticule light shield. Loosen the tube clamp at the base of the crt. Pull the crt straight out through the front panel (see Fig. 5-2).

When the new crt is in place, the leads can be properly connected to the neck of the tube by following the color code information provided on the tube shield. After replacement of the crt, it may be necessary to calibrate certain portions of the oscilloscope. Special attention should be given to calibration of the sweep and the vertical deflection factor.

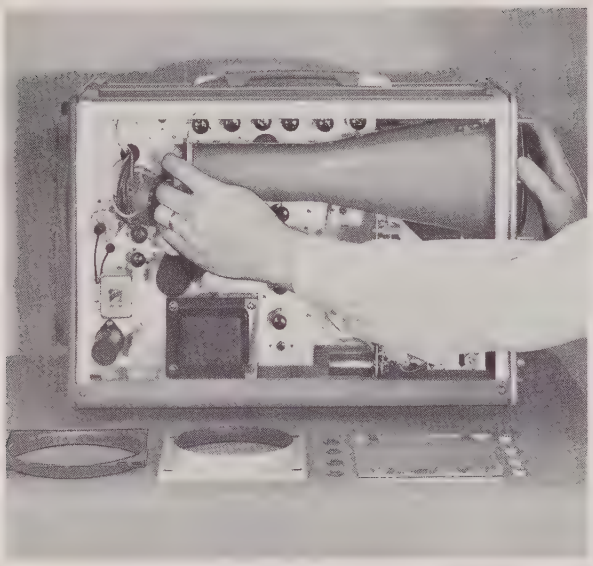


Fig. 5-2. Removing the cathode-ray tube.

Repacement of Switches

Methods for removal of defective switches are, for the most part, obvious and only a normal amount of care is required. Single wafers are normally not replaced on the switches used in the Type 503. If one wafer is defective, the entire switch should be replaced. Switches can be ordered from Tektronix, either wired or unwired, as desired.

Tube Relpacement

Care should be taken both in preventive and corrective maintenance that tubes are not replaced unless they are actually causing trouble. Often during routine maintenance it will be necessary to remove tubes from their sockets. It is important that these tubes be returned to their same sockets unless they are actually defective. Unnecessary replacement or switching of tubes will often necessitate calibration of the instrument. If tubes do require replacement, it is recommended that they be replaced by previously checked high-quality tubes.

Soldering Precautions

In the production of Tektronix instruments, a special silver-bearing solder is used to establish a bond to the ceramic terminal strips. This bond can be broken by repeated use of ordinary tin-lead solder, or by the application of too much heat. However, occasional use of ordinary solder will not break the bond if too much heat is not applied.

It is advisable to have a stock of solder containing about 3% silver if you frequently perform work on Tektronix instruments. This type of solder is used frequently in printed circuitry and should be readily available. It may also be purchased directly from Tektronix in one-pound rolls (order by part number 251-514).

Because of the shape of the terminals on the ceramic terminal strips, it is advisable to use a wedge-shaped tip in your soldering iron when installing or removing parts from the strips. A wedge-shaped tip allows you to apply heat directly to the solder in the terminals and reduce the amount of heat required. It is important to use as little heat as possible.

REPLACEMENT PARTS

Standard Parts

Replacements for all parts used in the Type 503 Oscilloscope can be purchased directly from Tektronix at current net prices. However, since most of the components are standard electronic parts, they can generally be obtained locally in less time than required to obtain them from the factory. Before ordering or purchasing parts, be sure to consult the parts list to determine the tolerances and ratings required. The parts list gives the values, tolerances, ratings, and Tektronix part number for all components used in the instrument.

Special Parts

In addition to the standard electronic components mentioned in the previous paragraph, special parts are also used in the assembly of the Type 503 Oscilloscope. These parts are manufactured or selected by Tektronix to satisfy particular requirements. Occasionally they are manufactured especially for Tektronix by other companies in accordance with Tektronix specifications. These parts, and most mechanical parts, should be ordered directly from Tektronix since they are normally difficult or impossible to obtain from other sources. All parts may be obtained directly from the factory or through the local Tektronix Field Office.

Parts Ordering Information

Each part in the Type 503 Oscilloscope has a 6-digit Tektronix part number. This number and a description of the part will be found in the parts list. When ordering parts, be sure to include the following information:

1. A description of the part.
2. The part number
3. The instrument type and serial number.

For example, a certain resistor should be ordered as follows: R143, 22.6 k ½ watt, fixed resistor, tolerance 1%, part number 309-136 for a Type 503 Oscilloscope, serial number _____. When parts are ordered in this manner we are able to fill your orders promptly, and delays that might result from transposed numbers in the part number are avoided.

NOTE

Always include the instrument TYPE and SERIAL NUMBER in any correspondence concerning this instrument.

Since the production of your instrument, some of the parts may have been superseded by new or improved components. In such cases, the part numbers of these new components will not be listed in the Parts List. However, if you order a part from Tektronix and it has been superseded by a new component, the new part will be shipped in place of the part ordered. Your local Tektronix Field Engineer has knowledge of these changes and may call if a change in your purchase order is necessary.

Replacement information sometimes accompanies the new components to aid in their installation.

Troubleshooting

TROUBLESHOOTING INFORMATION

The Troubleshooting section is divided into two sections; Circuit Isolation and Circuit Troubleshooting. Upon detecting an apparent trouble, you can refer to the Circuit Isolation section to locate the proper circuit to check. After determining which circuit is at fault, you can then refer to the Circuit Troubleshooting information, where the procedure for troubleshooting within the circuit is given. Before attempting to troubleshoot the Type 503, make sure that any apparent trouble is actually due to a malfunction within the instrument and not due to improper control settings. Operating instructions for the Type 503 are contained in Section 3 of this manual.

Although the Type 503 Oscilloscope is a stable instrument, many apparent troubles will be due to improper calibration of one or more circuits. One of the first steps in any troubleshooting procedure should be to check the calibration of the suspected circuit. A complete calibration procedure is given in Section 6 of this manual.

Power-supply output voltages should be checked whenever any type of trouble occurs in the instrument. Due to the circuit configuration employed in the Type 503, it is possible for an incorrect power-supply voltage to affect one circuit more than others. When all but one circuit in the oscilloscope is functioning properly, there is a tendency to overlook the power supply as a source of the trouble and to concentrate on the circuit where the trouble apparently exists. In cases of this type, valuable time may be saved by checking the power supplies first. If the output and ripple voltages of the regulated power supplies are correct, the power supplies can be assumed to be operating correctly.

When the trouble has been isolated to a definite circuit, perform a complete visual check of that circuit. Many troubles can be found easily by visual means. If a visual check fails to detect the cause of the trouble, check all tubes by substitution. Tube failure is the most prevalent cause of circuit failure. Do not depend on tube testers to adequately indicate the suitability of a tube for use in the instrument. The criterion for usability of a tube is whether or not it works satisfactorily in the instrument. Be sure to return any tubes found to be good to their original socket.

Separate circuit diagrams for each circuit are contained in the Parts List and Schematic Diagrams Booklet used in conjunction with this manual. In addition, a block diagram provides an overall picture of instrument operation. The reference designation of each electronic component in the instrument is shown on the circuit diagrams, in addition to important voltages and waveforms. The following chart lists the reference designations associated with each circuit.

All numbers less than 100	Sweep Trigger
All 100 numbers	Sweep Generator
All 300 numbers	Horizontal Amplifier and Horizontal Display Switch
All 400 numbers	Vertical Amplifier and Attenuator Switch
All 600 numbers	Power Supply
All 800 numbers	Crt Circuit and Calibrator

Switch wafers shown on the circuit diagrams are coded to indicate the position of the wafer on the actual switches. The number portion of the code refers to the wafer number on the switch assembly. Wafers are numbered from the front of the switch to the rear. The letters F and R indicate whether the front or the rear of the wafer is used to perform the particular switching function.

CIRCUIT ISOLATION

Although the Type 503 Oscilloscope is a complex instrument, it can be thought of as consisting of six main circuits in addition to the calibrator circuit. These are the:

1. Power Supply
2. Crt Circuit
3. Sweep Generator
4. Sweep Trigger
5. Vertical Amplifier
6. Horizontal Amplifier

The first circuit to check, for practically any type of trouble, is the Power Supply circuit. An improper output voltage from this supply will affect the operation of the entire instrument.

The crt display can often be used to isolate the trouble to one particular circuit when trouble obviously exists in that circuit. If there is no vertical deflection, for example, when the intensity and horizontal deflection appears to be normal, it is apparent that an open condition exists in the Vertical Amplifier and this circuit should be investigated first.

This portion of the troubleshooting procedure lists some of the troubles that can be caused by a circuit failure in the Type 503 Oscilloscope. It also describes checks that

can be made to isolate the faulty circuit or circuits. In some cases simple front panel checks can determine which circuit is defective, but in other cases internal checks and/or measurements are required.

The following troubleshooting information is divided according to the various types of trouble. Upon detecting an apparent trouble, you can use the symptoms to locate the proper circuit to check. After determining which circuit is at fault, you can refer to the Circuit Troubleshooting information, where the procedure for troubleshooting within the circuit is given.

No Spot or Trace

The inability to display a spot or trace on the face of the crt may be due to a defective power supply, an unbalanced condition in either or both of the deflection amplifiers, a defect in the Sweep Generator, or a defective Crt Circuit.

To determine which circuit is at fault, turn the INTENSITY control clockwise. Set the LEVEL control to FREE RUN and the SWEEP TIME/CM control to the 1 mSEC position. Set the HORIZONTAL DISPLAY switch to the SWEEP NORMAL X1 position.

The first section to check for trouble is the Power Supply. If the output voltages of the Power Supplies are correct (see Fig. 6-1), proceed to the next step.

A quick check for correct operation of the Sweep Generator is to turn the HORIZONTAL DISPLAY switch to the HORIZ. AMPLIFIER position. Adjust the VERTICAL POSITION and the HORIZONTAL POSITION controls. A spot should appear if the Sweep Generator is defective.

If a spot does not appear with the HORIZONTAL DISPLAY switch in the HORIZ. AMPLIFIER position, short the vertical deflection plates together. Be careful not to short either pin to the metal shield around the crt. Adjust the HORIZONTAL POSITION control and see if a spot appears on the crt. If so, a state of unbalance in the vertical deflection system is indicated.

If no spot appeared during the previous check, short the horizontal deflection plates together. Adjust the VERTICAL POSITION control and see if a spot now appears on the screen. If so, a state of unbalance in the horizontal deflection system is indicated.

If neither of the previous checks indicates the source of trouble, check the cathode voltage of V135B; this should be about +225 volts. This voltage is the unblanking potential for the crt and must be applied to the crt to obtain a spot or trace.

If none of the previous checks indicates the source of trouble, a defective crt or trouble in the Crt Circuit is indicated.

Insufficient Vertical Deflection, Waveform Distortion, or Low Differential Input Rejection Ratio

These troubles are all caused by a defective vertical amplifier. Refer to the Circuit Troubleshooting section of the Troubleshooting procedure.

Insufficient or No Horizontal Deflection

Either of these conditions can be produced by the Sweep Generator or the Horizontal Amplifier. If the sweep is shortened but the timing is not affected, the trouble is probably in the Sweep Generator. If both the sweep length and the timing are affected, the trouble is probably in the Horizontal Amplifier.

As an additional check to determine which circuit is defective, place the HORIZONTAL DISPLAY switch in the HORIZ. AMPLIFIER position. Set the HORIZONTAL SENSITIVITY switch to the .1 VOLTS/CM position and the VARIABLE control fully clockwise. Connect the 500 mV calibrator signal to the +INPUT connector of the horizontal channel.

Two dots, spaced 5 cm apart, should appear when the positioning controls are adjusted. If the deflection is correct, the trouble is probably in the Sweep circuit. If the deflection is not correct, the trouble is in the Horizontal Amplifier.

Nonlinear Horizontal Sweep

The linearity of the horizontal deflection can be checked by connecting a marker generator or the calibrator output to a vertical input of the oscilloscope. If the sweep is linear, the markers or the calibrator waveform will be spaced equidistant along the sweep. A nonlinear sweep can be caused by either the Sweep Generator or the Horizontal Amplifier.

To determine which circuit is defective, place the HORIZONTAL DISPLAY switch in the HORIZ. AMPLIFIER position. Set the HORIZONTAL SENSITIVITY control to .5 VOLTS/CM position and the VARIABLE control fully clockwise. Connect the 500 mV signal from the CAL. OUT connector to the +INPUT connector of the Horizontal Channel.

Two dots, spaced 1 cm apart, should appear when the positioning controls are adjusted. If the spacing between dots remains the same as they are moved across the screen with the HORIZONTAL POSITION control the nonlinearity is probably in the Sweep Generator. If the spacing between dots varies, the trouble is in the Horizontal Amplifier.

Improper Sweep Timing

If the timing is off in some, but not all, positions of the SWEEP TIME/CM switch, one of the timing resistors or timing capacitors has changed in value. By comparing the switch positions in which the timing is incorrect with the Timing Switch diagram, you will be able to tell which components are common to these positions.

If the timing is off in all positions of the SWEEP TIME/CM switch, the Horizontal Amplifier is probably the circuit at fault. However, it is important that the power supply voltages be checked. Check to see if the timing circuits can be calibrated in accordance with the instructions presented in the Calibration section of this manual. If the circuits cannot be adjusted for correct timing, then refer to the section on troubleshooting the Horizontal Amplifier.

Improper Triggering

If the waveform you are observing cannot be triggered (locked into position) properly, the trouble can be misadjustment of the STABILITY control or malfunction of some other part of the Sweep circuit or the Trigger circuit.

Check the adjustment of the STABILITY control as described in the Calibration section of this manual. If the trace can be turned on and off by rotating the LEVEL control into and out of the FREE RUN position, the Trigger circuit is probably causing the trouble. If the trace cannot be turned off with the LEVEL control, the Sweep circuit is likely at fault.

CIRCUIT TROUBLESHOOTING

This portion of the Troubleshooting procedure contains information for locating a defective stage within a given circuit. Once the stage at fault is known, the component or components causing the trouble can be located by tube and component substitution, voltage and resistance measurements, or by short and continuity checks.

As mentioned previously, tube failure is the most prevalent cause of circuit failure. For this reason, the first step in troubleshooting any circuit is to check for defective tubes, preferably by direct substitution. Be sure to return any tubes found to be good to their original sockets.

If replacement of a defective tube does not correct the trouble, then check to see that components through which the tube draws current have not been damaged. Shorted tubes will often overload and damage plate load and cathode resistors. These components can sometimes be located by a visual inspection of the circuit. If no damaged components are apparent, however, it will be necessary to make measurements or other checks within the circuit to locate the trouble.

Troubleshooting the Power Supply

Proper operation of every circuit in the Type 503 Oscilloscope depends on proper operation of the Power Supply. The voltages must remain within their specified tolerances for the instrument to maintain its calibration.

No Output Voltage. If the graticule lamps do not operate when the POWER switch is turned on, check the POWER switch, the fuse and line voltage. Shorts in the primary and secondary circuits of T601 will cause the fuse to blow. If the fuse is not blown and the line voltage is correct, next check the primary windings of the power transformer.

If the graticule lamps operate correctly, the primary circuit of the power transformer (T601) is operating normally and the trouble lies somewhere in the secondary circuit or the oscillator circuit (V620, T620).

To check the secondary circuit of T601, measure the voltage at the junction of D612 and C612 (Fig. 6-1). This voltage should be approximately +500 volts. Check the secondary winding of T601 and the voltage doubler circuit if the voltage is not correct. A reading of approximately 600 volts or more at the junction of D612 and C612 indicates the oscillator circuit (V620, T620) is inoperative. Before replacing V620, check for defective parts associated with V620. Some of the parts to check, for example, are T620, C620, C621, and R621.

If the proper output voltage is obtained from at least one of the power supplies, the oscillator circuit need not be checked. In this case, you should check the rectifier and components associated with the inoperative supply.

Failure to Regulate at the Correct Voltage. If the supplies fail to regulate at the proper voltages, first check the line voltage. The supplies are designed to regulate between an input voltage of 105 and 125 volts (or 210 and 250 volts), with the design center at 117 volts (or 234 volts), rms. Improper line voltage may cause the supply voltages to be off.

If the output of any of the supplies is off by only a small amount, it may be possible to readjust the —100 ADJ. control to obtain the proper voltage. It should be noted that when the setting of the —100 ADJ. control is changed, the entire instrument must be recalibrated according to the procedure given in Section 6 of this manual.

If the supplies fail to regulate, check the tubes (if this has not already been done). Then make sure that the voltage at the junction of D612 and C612 is approximately +500 volts. Check for off-value resistors, especially in the dividers, and for open or leaky capacitors associated with V634.

If there is excessive ripple on only one of the supplies, check for open or leaky capacitors in that circuit.

Troubleshooting the Crt Circuit

Trouble other than power supply trouble which affects the Crt Circuit will generally be caused by defects in the intensity and focus voltage dividers, defects in the divider associated with pins 7 and 11 of the crt, by the astigmatism control, or by the crt itself. These parts (except for the crt) can be checked by voltage and resistance measurements. If the circuits check out satisfactorily replace the crt.

Troubleshooting the Vertical Ampifier

No Spot or Trace. As mentioned earlier in the troubleshooting procedure, if a spot is visible when the vertical plates are externally shorted together, but disappears when the short is removed, the Vertical Amplifier is in a state of dc unbalance. To locate the defective stage, first set both INPUT switches to the GND position and the SENSITIVITY switch to the .2 VOLTS/CM position. Then, with an insulated shorting strap, short between the points shown in Fig. 5-3, starting at the right and progressing toward the left. As you short between the points, in turn, the spot should appear on the screen as each connection is made. You may have to readjust the POSITION control when shorting between plates of the input stage. With the input stage grounded, the DC BAL. control may have to be readjusted.

When you reach a point where the spot does not return to the screen, the stage immediately following this point is at fault. The trouble may be caused by a defective tube, transistor, resistor, capacitor, or broken lead.

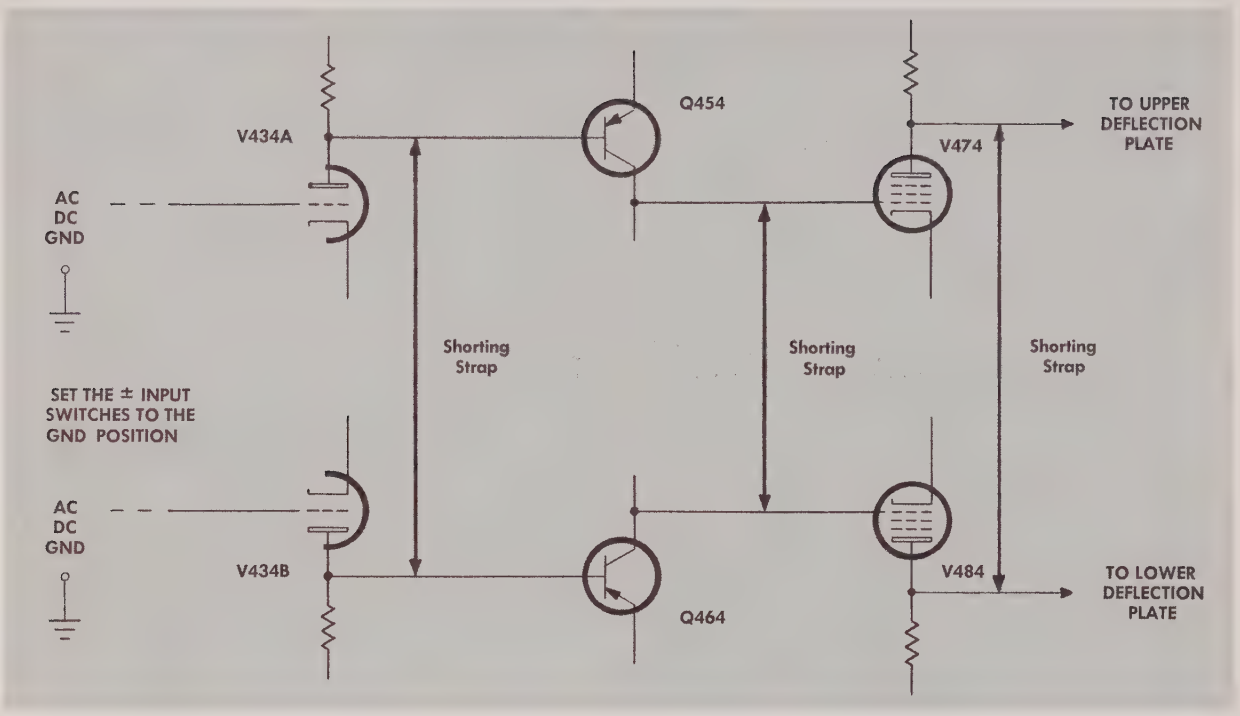


Fig. 5-3. Checking the Vertical Amplifier for an unbalance condition.

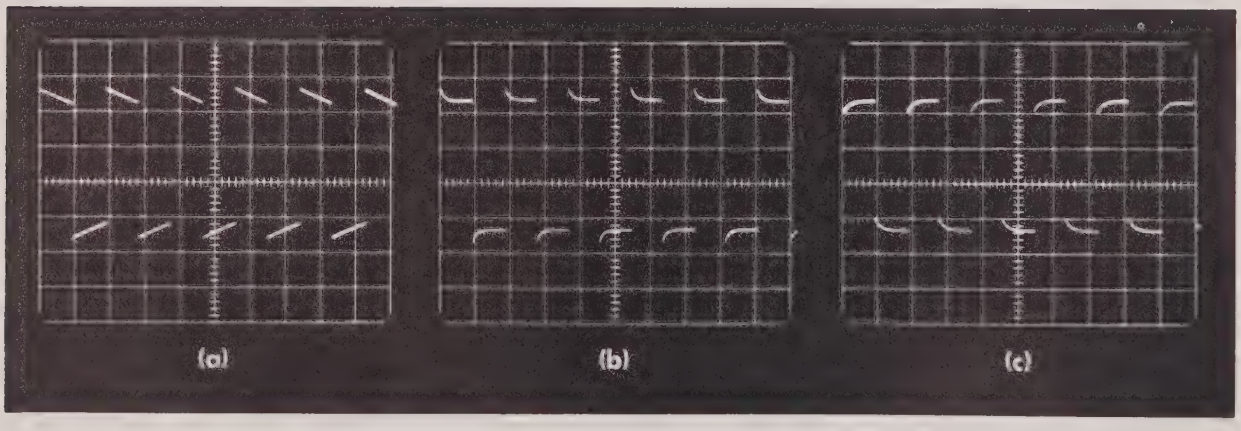


Fig. 5-4. Frequency distortion. (a) Low-frequency distortion of an ac-coupled 100-cps square wave due to attenuation of the low-frequency components of the waveform. (b) High-frequency distortion of a 1000-cps square wave due to excessive boost of the high-frequency components of the waveform. (c) High-frequency distortion of a 1000-cps wave due to attenuation of the high-frequency components of the waveform.

Insufficient or No Vertical Deflection. Insufficient vertical deflection indicates a change in the gain characteristics of the Vertical Amplifier. If the change in gain is small, the Vertical Amplifier can usually be calibrated for gain. In this event, refer to the Calibration section of this manual.

If the change in gain is more pronounced, or if there is no vertical deflection at all, the tubes and transistors should first be checked. Then check for components which can affect the gain of the circuit but not the dc balance. Such parts are common cathode resistors in the Input and Output Amplifier stages, or plate dropping resistors which are common to both sides of the amplifier.

Insufficient vertical deflection will also be caused if the frequency limits of the amplifier are exceeded.

Waveform Distortion. Waveform distortion can be divided into two categories—low frequency and high frequency. If a square wave is applied to an input of the oscilloscope, the type of distortion can be determined by the shape of the displayed waveform. High frequency distortion will primarily affect the leading edge and trailing edge of the applied square wave while low frequency distortion will primarily affect the midportion of the waveform.

Waveforms showing low frequency distortion and two types of high frequency distortion are shown in Fig. 5-4. The shape of these waveforms will vary widely, however, with the cause of the distortion and the frequency of the applied waveform. A nominal amount of low frequency distortion is normal for very low input frequencies when ac coupling is used, and a nominal amount of high frequency distortion is normal at the upper frequency limits of the instrument. It is only when this distortion is excessive in the normal frequency range of the instrument that it constitutes a trouble.

Low frequency distortion is usually caused by a change in the time constant of the input coupling circuit. If tubes become gassy, however, their resultant grid current will establish a time constant network which will affect the low frequency response of the circuit.

Factors which can affect the high frequency response of the vertical amplifier are mainly related to the high frequency compensation networks. An overshoot waveform can be caused by excessive high-frequency peaking or by a tube condition known as cathode interface. If this type of distortion is detected, check the tubes in the amplifier. If tube replacement does not completely correct the trouble, then check the adjustment of C406 and C416 and the high frequency compensation networks in the attenuators. Refer to the Calibration section of this manual.

Undershoot or rolloff can be caused by insufficient high-frequency peaking and by tubes. If tube replacement does not correct this type of distortion, then check the adjustments of C406 and C416 and the divider networks in the attenuators.

Low Differential Input Rejection Ratio. Low rejection ratio is usually caused by tubes or transistors. If replacement of tubes or transistors does not correct the trouble, then check for components which can affect the balance of the circuit.

Troubleshooting the Horizontal Amplifier

If a spot is visible when the horizontal deflection plates are externally shorted together, but disappears when the short is removed, the Horizontal Amplifier is in a state of unbalance.

When the HORIZONTAL DISPLAY switch is in the HORIZ. AMPLIFIER position, the operation of the Horizontal Amplifier is virtually identical to that of the Vertical Amplifier. Therefore, the procedure for troubleshooting the Horizontal Amplifier is the same as that explained previously for troubleshooting the Vertical Amplifier.

Troubleshooting the Sweep Trigger Circuit

To determine which stage is defective, rotate the TRIGGER LEVEL control fully counterclockwise to the AUTO. position. With no triggering signal, the sweep should appear on the crt. If the sweep does not appear, either the Trigger Multivibrator is defective or the SWEEP STABILITY ADJUST is misadjusted. Refer to the Calibration section for adjustment procedures for the SWEEP STABILITY ADJUST. If the sweep does appear, either the Trigger Amplifier or the Trigger Multivibrator may be at fault.

A check on the Trigger Amplifier circuit may be made as follows. With the LEVEL control still in the AUTO. position, measure the voltage at the plate, pin 6, of V24B. This voltage should be approximately +98 volts. If the voltage is incorrect, the trigger amplifier circuit is defective. The trouble will probably exist in the tube, resistors, or switches of the circuit.

If the voltage measured at pin 6 of V24B is correct, rotate the LEVEL control completely through its range while monitoring the voltage at this point. The voltage should vary between approximately 70 and 130 volts. An incorrect voltage range indicates a defective amplifier or LEVEL control. If the voltage range is correct, the trouble is in the trigger multivibrator. A trouble in the multivibrator will probably be due to a defective tube or resistor. The voltage divider network between the plate of V45A and the grid of V45B is particularly critical.

Troubleshooting the Sweep Generator Circuit

It is important that you understand the operation of the Sweep Generator circuit before proceeding with any extensive investigation of the circuit. For this reason, we suggest that you thoroughly study that portion of the Circuit Description that pertains to this circuit.

No Horizontal Sweep. If the sweep circuit is not producing a sawtooth waveform when the TRIGGER LEVEL control is in the FREE RUN position, some defect in the circuit is causing the output to remain at some fixed voltage. A clue to the cause of this trouble can be obtained by measuring the plate voltage of the Miller tube, V160A.

NOTE

All voltages in this section should be measured with a 20,000 ohms-per-volt voltmeter or a vacuum-tube voltmeter.

The voltage reading obtained will probably be approximately +200 volts, or approximately +30 volts. A reading of +200 volts indicates that the Miller stage has run up and has not been reset, while a reading of +30 volts indicates that the Miller stage is not being allowed to run

up. The condition that actually exists will depend on the type of trouble occurring in the circuit. The two conditions of the plate voltage will be handled separately in the following paragraphs.

High voltage at the plate of the Miller tube, V160A, indicates the tube is cut off. This can result from any one of the following conditions: (1) The Disconnect Diodes do not conduct, (2) Sweep-Gating Multivibrator does not reset, (3) Hold off Circuit does not reset the Sweep-Gating Multivibrator and, (4) Runup Cathode Follower does not drive the Hold-Off Circuit. The defective stage can be detected by a series of systematic voltage measurements. When an improper voltage reading is obtained, this will indicate the defective stage.

Check the voltage at the grid of the Miller tube, pin 2, V160A. The static voltage at the Miller grid is determined by conduction through the Timing Resistor, R160 (from —100-volt bus), the lower diode, V152B, and resistor R147. If the voltage reading is less than —4 volts, V152B is probably conducting normally and can be eliminated as a possible cause of the trouble. If the voltage is more negative than approximately —20 volts, the diode is probably not conducting. Check V152 and resistor R147.

Measure the voltage at the output of the Sweep Generator circuit (pin 8 of V160B). If this voltage is approximately +150 volts, the Runup Cathode Follower stage may be assumed to be operating correctly. If this voltage is low, however, the stage is defective and its grid and cathode circuits should be checked.

Next, measure the voltage at the cathode of V145B, pin 3. If this voltage is more positive than —55 volts the trouble is in the Sweep-Gating Multivibrator. Check the tubes and resistors in this circuit. The voltage divider network in the cathode of V135B is particularly critical.

If the voltage at the cathode of V145B, pin 3, is more negative than —55 volts, check the tubes in the Hold-Off Circuit, the Hold-Off capacitor, and resistors in the cathode circuit of the two tubes.

Low voltage at the plate of the Miller tube indicates that the tube is conducting quite heavily and is not being allowed to perform its normal runup operation. If this trouble exists on only a few ranges of the SWEEP TIME/CM switch, the trouble is likely to be an open timing resistor. If the trouble exists on all ranges of the SWEEP TIME/CM switch, the trouble is probably due to a defective Sweep-Gating Multivibrator.

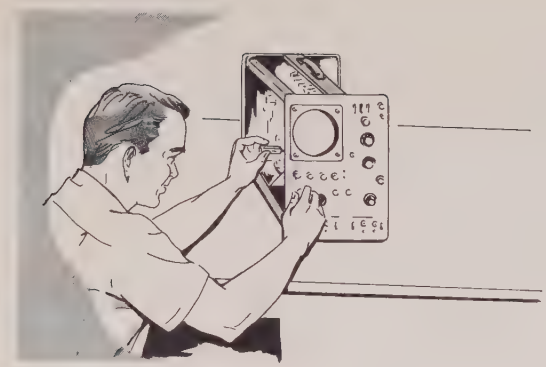
To check the Sweep-Gating Multivibrator, monitor the voltage at pin 3 of V145B and adjust the STABILITY ADJUST control for a reading of —66 volts on the voltmeter. With this voltage, the Sweep-Gating Multivibrator and the sweep should free run. If the multivibrator does not free run, check the resistances in the stage.

If the voltage at pin 3 of V145B remains relatively constant as the STABILITY ADJUST control is rotated, a defect in the Hold-Off Circuit is indicated. A probable cause of this condition could be a shorted hold-off capacitor. If the voltage does not adjust to the proper level, check the resistors in the cathode circuit of V145B.

Nonlinear Sweep. A nonlinear sweep voltage will be generated if the current charging the Timing Capacitor does not remain constant. If the nonlinearity exists at all sweep rates, a defective Miller tube (V160A) is the probable cause of the trouble. If the nonlinearity occurs only at certain sweep rates, a faulty Miller tube or a leaky Timing Capacitor is the probable cause.

Insufficient Horizontal Deflection. If the horizontal trace starts at the left-hand side of the screen, but does not extend to the right-hand side, the Hold-Off Circuit is resetting the Sweep-Gating Multivibrator before the sweep is complete. If the sweep cannot be adjusted to normal length with the SWP. LENGTH control, R176, the resistance in the cathode circuit of V160B should be checked.

Improper Triggering. If the sweep cannot be triggered properly, the gating pulse from the Multivibrator is not turning the Disconnect Diodes (V152A&B) off and on properly. The start of the gating pulse, which turns the diodes off and starts the sweep, is initiated by the triggering pulse at the grid of V135A. The end of the gating pulse, which turns the diodes on and initiates the retrace, is controlled by the hold-off waveform at the grid of V135A. The main component to check, in addition to the tubes, is the differentiating capacitor C131. Misadjustment of the STABILITY ADJUST control (R111) will also cause the Sweep Generator to trigger improperly. Refer to the Calibration section for correct adjustment.



SECTION 6

CALIBRATION

INTRODUCTION

The Type 503 Oscilloscope is a stable instrument and should not require frequent calibration. However, it will be necessary to calibrate certain parts of the instrument when tubes or components are changed. Also, a periodic calibration is desirable from the standpoint of preventive maintenance.

Apparent trouble in the instrument may be due to improper calibration of one or more circuits. Consequently this section of the manual should be used in conjunction with the Maintenance section during troubleshooting work. If trouble occurs in the instrument, you must be sure that it is not due to improper calibration before proceeding with more detailed troubleshooting.

In the instructions that follow, the steps are arranged in the proper sequence for a complete calibration of the instrument. Each numbered step contains the information required to make one adjustment or a series of related adjustments. Controls not mentioned in a given step are assumed to be set at the positions they were last in during the preceding step.

If a single control requires adjustment, and the particular control is known, it can often be adjusted without calibrating the entire instrument, provided the control does not interact with other adjustments. In such cases, the control is adjusted in the normal manner, as described in the applicable calibration step. It may be necessary, however, for you to refer to the calibration steps immediately preceding the adjustment you wish to make to determine the proper setting for the controls not mentioned in that step. Due to the interaction between adjustments in the horizontal and vertical amplifiers, single adjustments in these circuits usually cannot be made. When amplifier adjustments are required, the entire amplifier should be calibrated. In addition, if the —100-volt supply is adjusted, the entire instrument must be calibrated.

Fig. 6-6 and Fig. 6-7 show the location of the internal adjustments referred to in the calibration procedure.

EQUIPMENT REQUIRED

The following equipment is necessary for a complete calibration of the Type 503 Oscilloscope.

1. DC voltmeter (sensitivity of at least 5000 Ω/v), calibrated for an accuracy of 1% at 12.6, 85, 100, and 250 volts, and for an accuracy of 3% at 3000 volts.

2. Accurate rms-reading ac voltmeter, having a range of at least 0-125 volts. (0-250 for 234-volt operation.)

3. Variable autotransformer having a rating of at least 500 watts.

4. Time-Mark Generator, Tektronix Type 180 or Type 180A or equivalent. Time-mark generator used must have markers at 1 μsec, 10 μsec, 100 μsec, 1 msec, 5 msec, 10 msec, 100 msec, 1 sec, and 5 sec, with an accuracy of at least 1%.

5. Square-Wave Generator, Tektronix Type 105 or equivalent. Required specifications are: (1) output frequency of approximately 1 kilocycle, (2) risetime of 0.02 microsecond or less, and (3) output amplitude variable from about 40 millivolts to 100 volts.

6. Test oscilloscope with calibrated vertical deflection factors from .01 to 10 volts per division.

7. Low-capacitance calibration tool: Tektronix part number 003-000 (see page 11, Accessories Section) or equivalent.

8. Coaxial Cable suitable for applying the outputs of the square-wave generator and the time-mark generator to the inputs of the Type 503.

9. 47-μμf Input Capacitance Standardizer, Tektronix Type CS47 or equivalent.

ADJUSTMENT PROCEDURE

Preliminary

Remove the side covers from the Type 503 Oscilloscope. Set the front panel controls as follows (controls not listed may be left in any position):

SLOPE	+
COUPLING	AC
SOURCE	INT.
LEVEL	ccw but not AUTO.
SWEEP TIME/CM	1 mSEC
VARIABLE	CALIBRATED (fully cw)
INTENSITY	Fully ccw
HORIZONTAL DISPLAY	SWEEP NORMAL (X1)
VERTICAL	
SENSITIVITY	.1 VOLTS/CM

VARIABLE	CALIBRATED (fully cw)
POSITION	midrange
+INPUT	DC
—INPUT	GND

Connect the Type 503 Oscilloscope to the autotransformer, and turn on all equipment. Set the output of the autotransformer to the design center voltage for which your instrument is wired (117 or 234 volts). Allow the instrument to warm up for at least 5 minutes before proceeding with the calibration adjustments.

Power Supply

1. —100 ADJ. With the dc voltmeter measure the output voltage of the —100-, +12.6-, +100-, +250-, and —3000-volt supplies at the points indicated in Fig. 6-1. Set the —100 ADJ. control so that the —100-volt supply is within 2% and the other supplies within 5% of their rated vales.

NOTE

Do not adjust the —100 ADJ. control unless one or more of the supplies is actually out of tolerance or unless you are planning to perform a complete recalibration of the instrument.

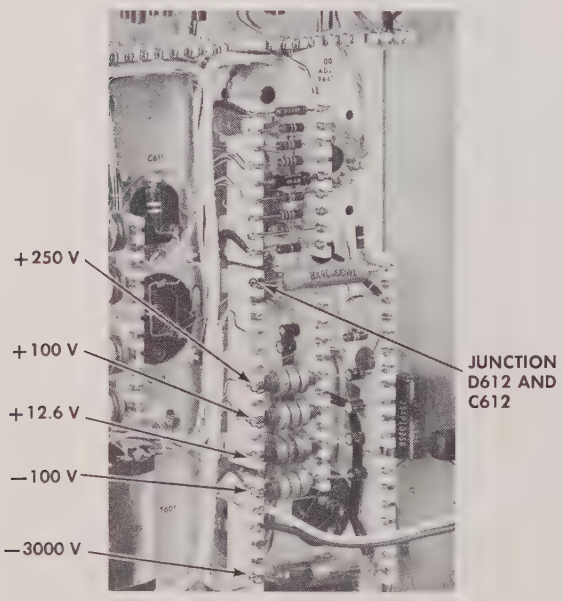


Fig. 6-1. Location of Power Supply test points.

2. Regulation. Vary the autotransformer output voltage between 105 and 125 volts (or between 210 and 250 volts if the power transformer is wired for 234-volt operation). All of the regulated voltages should remain within tolerance over this range.

3. Ripple. Using the test oscilloscope, check the 120-cycle ripple voltage at the output of each power supply when the output voltage of the autotransformer is set for 117 volts (or 234 volts). Ripple at the output of all of the power supplies, except the —3000-volt supply, should be 25 millivolts or less. Do not attempt to measure the ripple on the —3000-volt supply.

Calibrator

4. CAL. ADJ. Connect the input of the test oscilloscope to the CAL. OUT 500 mV terminal on the front panel. Adjust the CAL. ADJ. control (R880) for an output amplitude of 500 millivolts. Disconnect the test oscilloscope.

Crt Circuit

5. Crt Alignment. Check to see that the crt rests snugly against the graticule. If it does not, loosen the crt clamp (see Fig. 6-6) and push the tube forward by pushing on the tube socket. Then tighten the crt clamp.

Set the LEVEL control to the FREE RUN position. Turn up the INTENSITY control until a trace is visible (it may be necessary to adjust the VERTICAL POSITION control) and adjust the FOCUS and ASTIGMATISM controls for the narrowest trace width. With the VERTICAL POSITION control, position the trace directly behind the center graticule line. If the trace is tipped relative to the graticule line, rotate the crt alignment knob until the trace coincides with the graticule line.

6. Astigmatism Adjust.* Rotate the FOCUS control fully clockwise and set the HORIZONTAL DISPLAY switch to the HORIZ. AMPLIFIER position. Position the spot onto the screen, and adjust the ASTIG. ADJ. control so that the defocused spot is as nearly circular as possible. Adjust the FOCUS control so that the spot is in sharp focus. The INTENSITY control may have to be adjusted to produce a defocused circle, but care should be taken not to burn the crt face when a sharply focused spot is produced.

Triggering Circuit

7. SWEEP STABILITY ADJUST.** Set the VERTICAL SENSITIVITY control to the .1 VOLTS/CM position and the HORIZONTAL DISPLAY switch to the SWEEP NORMAL position. Set the LEVEL control to the FREE RUN position and center the trace vertically on the screen. Adjust the INTENSITY and FOCUS controls for best definition. Reset the LEVEL control to AUTO. (full left). Set the SWEEP STABILITY ADJUST control (R111, screwdriver adjustment, front panel) fully counterclockwise. Next, turn the SWEEP STABILITY ADJUST control clockwise until a trace is visible on the crt. Note the position of the control. Then, advance the control further clockwise until the trace brightens. Back off the control and set it midway between the point where the trace first becomes visible and the point where it brightens.

* Make this adustment only on instruments having serial number 000270 or higher. On instruments having serial numbers lower than 000270, the ASTIGMATISM control is located on the front panel and is easily adjusted during operation of the oscilloscope.

** Although this control is shown on the Sweep Generator circuit diagram, it is more closely associated with the triggering circuitry and its adjustment is therefore included in this section.

Vertical Amplifier

8. COARSE DC BAL. Rotate the LEVEL control to the FREE RUN position. Set the SENSITIVITY control to .2 VOLTS/CM and the VARIABLE control to the CALIBRATED position. Set the DC BAL. control to midrange. Set both VERTICAL INPUT switches to the GND position. Center the trace vertically on the crt with the POSITION control. Adjust the COARSE DC BAL. control (R436) so that the trace does not shift vertically as the SENSITIVITY switch is rotated between the .2 VOLTS/CM and the 1 mV/CM positions.

9. .2V GAIN ADJ. This adjustment and the following step determine the gain of the Vertical Amplifier and therefore the calibration of the SENSITIVITY switch. To adjust the .2V GAIN ADJ. (R478), set the front-panel controls as follows:

SLOPE	+
COUPLING	AC
SOURCE	INT.
LEVEL	AUTO
SWEEP TIME/CM	1 mSEC
VARIABLE	CALIBRATED
HORIZONTAL DISPLAY	SWEEP NORMAL (X1)
VERTICAL	
SENSITIVITY	.1 VOLTS/CM
VARIABLE	CALIBRATED
+INPUT	DC
—INPUT	GND

Connect a jumper wire from the CAL. OUT 500 mV connector to the +INPUT connector. Adjust the FOCUS, INTENSITY, and POSITION controls for a suitable display. Adjust the .2V GAIN ADJ. control for a deflection of five centimeters.

10. 1 mV GAIN ADJ. Connect the jumper wire from the CAL. OUT 5 mv connector to the +INPUT connector. Set the SENSITIVITY switch to 1 mV/CM. Make sure the SENSITIVITY VARIABLE control has not been moved from the CALIBRATED position. You may have to adjust the DC BAL. control to position the display on the screen. Adjust the 1 mV GAIN ADJ. control (R460) for five centimeters of vertical deflection. Repeat steps 9 and 10 until both adjustments are correct. Disconnect the jumper wire.

11. High-Frequency Compensation. To adjust the high-frequency compensation of the attenuators, set the front-panel controls as follows:

SLOPE	+
COUPLING	AC
SOURCE	INT.
LEVEL	AUTO.
SWEEP TIME/CM	.5 mSEC
VARIABLE	CALIBRATED
HORIZONTAL DISPLAY	SWEEP NORMAL (X1)
VERTICAL	
SENSITIVITY	.2 VOLTS/CM
VARIABLE	CALIBRATED
+INPUT	DC
—INPUT	GND.

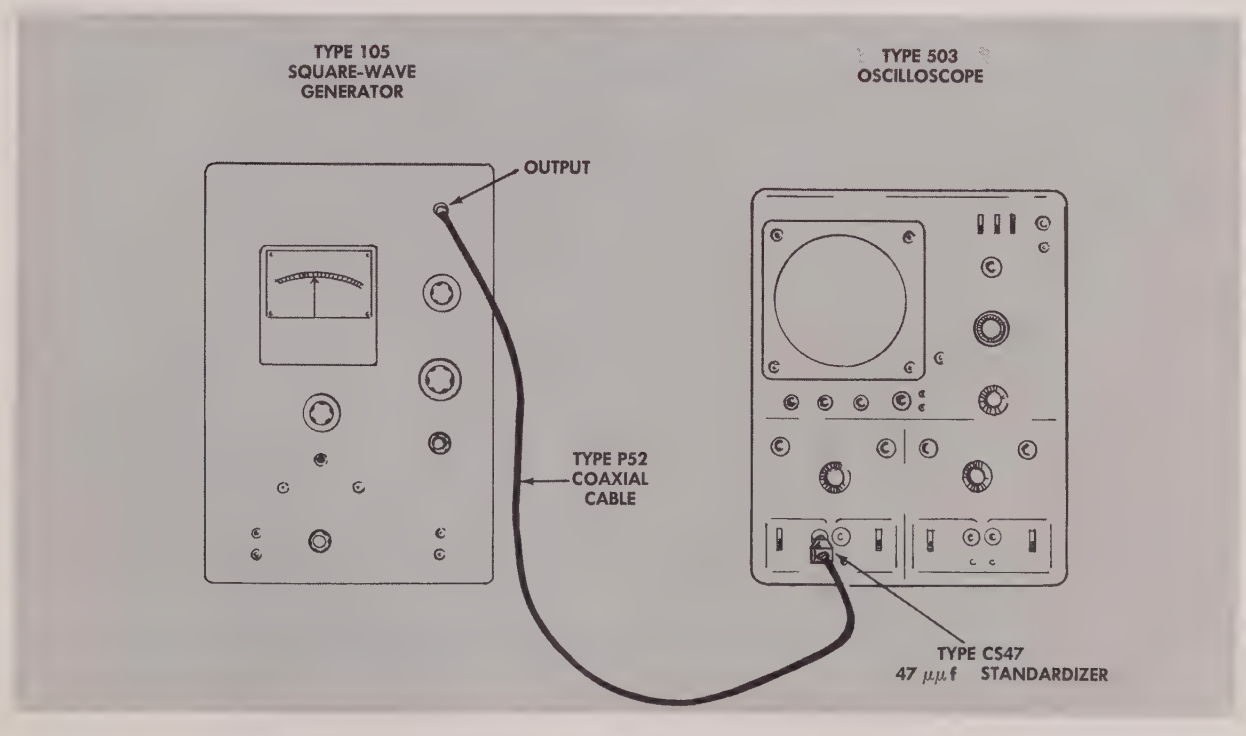


Fig. 6-2. Tektronix Type 105 Square-Wave Generator connected for high-frequency compensation of the Type 503 Oscilloscope Vertical Amplifier.

Connect the output of the square-wave generator through the 47-$\mu\mu$f capacitance standardizer to the +INPUT connector of the Type 503. Adjust the square-wave generator for an output frequency of 1 kc. Fig. 6-2 shows the Tektronix Type 105 Square-Wave Generator connected for this step.

Set the SENSITIVITY control to the positions indicated in Table 6-1 and adjust the corresponding capacitors for the best square-wave response. C416, C415B, and C414B affect the overall level of the square wave; C415C and C414C have the most effect on a small portion of the leading edge and corner. Maintain about four centimeters of vertical deflection by adjusting the output amplitude of the square-wave generator as you switch the SENSITIVITY control from one setting to the next.

TABLE 6-1

SENSITIVITY	ADJUST
.2 VOLTS/CM	C416
.5 VOLTS/CM	C415B, C415C
5 VOLTS/CM	C414B, C414C

Connect the output of the square-wave generator through the 47-$\mu\mu$f capacitance standardizer to the —INPUT connector. Set the —INPUT switch to the DC position and the +INPUT switch to the GND position.

Set the SENSITIVITY control to the positions indicated in Table 6-2 and adjust the corresponding capacitors for the best square-wave response.

TABLE 6-2

SENSITIVITY	ADJUST
.2 VOLTS/CM	C406
.5 VOLTS/CM	C405B, C405C
5 VOLTS/CM	C404B, C404C

Disconnect the 47-$\mu\mu$f capacitance standardizer from the —INPUT connector.

Horizontal Amplifier

12. COARSE DC BAL. Set the HORIZONTAL DISPLAY switch to the HORIZ. AMPLIFIER position. Set the HORIZONTAL SENSITIVITY control to .2 VOLTS/CM and the VARIABLE control to the CALIBRATED position. Set the DC BAL. control to midrange. Set both INPUT switches to the GND position. Center the spot horizontally on the crt with the HORIZONTAL POSITION control. Adjust the COARSE DC BAL. control (R346) so that the spot does not shift horizontally as the SENSITIVITY switch is rotated between the .2 VOLTS/CM and the 1 mV/CM positions.

13. .2V GAIN ADJ. This adjustment and the following step determine the gain of the Horizontal Amplifier and therefore the calibration of the SENSITIVITY switch. To adjust the .2V GAIN ADJ. (R378), set the front-panel controls as follows:

HORIZONTAL DISPLAY	HORIZ. AMPLIFIER
HORIZONTAL SENSITIVITY	.1 VOLTS/CM
VARIABLE	CALIBRATED
+INPUT	DC
—INPUT	GND

Connect a jumper wire from the CAL. OUT 500 mV connector to the +INPUT connector. Two dots, spaced approximately five centimeters apart, should appear on the screen. Adjust the FOCUS, INTENSITY, and POSITION controls for a suitable display. Adjust the .2V GAIN ADJ. control for a deflection of exactly five centimeters.

14. 1 mV GAIN ADJ. Connect the jumper wire from the CAL. OUT 5 mV connector to the +INPUT connector. Set the SENSITIVITY switch to 1 mV/CM. Make sure the SENSITIVITY VARIABLE control has not moved from the CALIBRATED position. You may have to adjust the DC BAL. control to position the signal on the screen. Adjust the 1 mV GAIN ADJ. control (R360) for five centimeters of horizontal deflection. Repeat steps 13 and 14 until both adjustments are correct. Disconnect the jumper wire.

15. High-Frequency Compensation. To adjust the high-frequency compensation of the horizontal attenuators, a vertical trace must be obtained by connecting the output of the Sweep Generator to the Vertical Amplifier. To do this, connect the bottom of R144 to an internal source of —100 volts and connect pin 8 of V160 to the +INPUT connector of the Vertical Amplifier. Fig. 6-3 illustrates how these connections can be made.

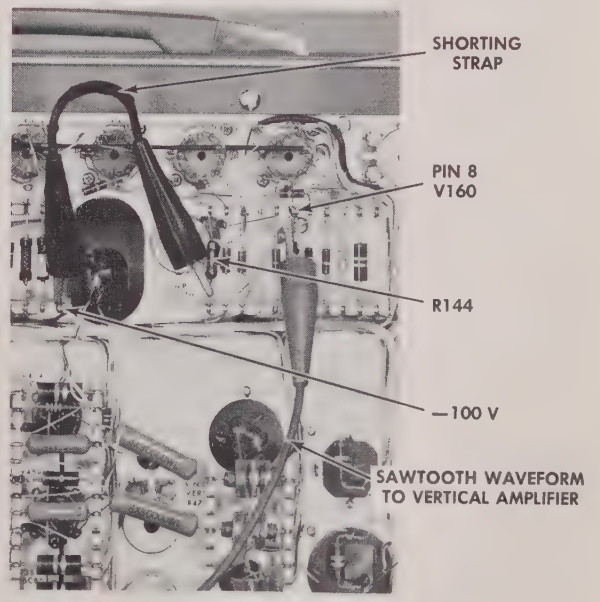


Fig. 6-3. Connections for obtaining a vertical trace on the Type 503 Oscilloscope.

Set the front panel controls as follows:

SLOPE	+
COUPLING	AC
SOURCE	EXT.
LEVEL	AUTO.
SWEEP TIME/CM	1 mSEC
VARIABLE	CALIBRATED
HORIZONTAL DISPLAY	HORIZ. AMPLIFIER
HORIZONTAL	
SENSITIVITY	.2 VOLTS/CM
VARIABLE	CALIBRATED
+INPUT	DC
—INPUT	GND
VERTICAL	
SENSITIVITY	10 VOLTS/CM
VARIABLE	CALIBRATED
+INPUT	DC
—INPUT	GND.

Connect the output of the square-wave generator through the 47-$\mu\mu$f capacitance standardizer to the HORIZONTAL +INPUT connector of the Type 503. Connect a synchronizing output signal from the square-wave generator to the EXTERNAL TRIG. IN connector of the Type 503. Adjust the square-wave generator for an output frequency of 1 kc. Fig. 6-4 shows the Tektronix Type 105 Square-Wave Generator connected for this step.

Adjust the FOCUS, INTENSITY, and POSITION controls for a suitable display. The display should be similar to Fig. 6-5. Set the SENSITIVITY control to the positions indicated in Table 6-3 and adjust the corresponding capacitors for the best square-wave response. Maintain about four centimeters of horizontal deflection by adjusting the output amplitude of the square-wave generator as you switch the SENSITIVITY control from one setting to the next.

TABLE 6-3

SENSITIVITY	ADJUST
.2 VOLTS/CM	C306
.5 VOLTS/CM	C305B, C305C
5 VOLTS/CM	C304B, C304C

Connect the output of the square-wave generator through the 47-$\mu\mu$f capacitance standardizer to the —INPUT connector. Set the —INPUT switch to the DC position and the +INPUT switch to the GND position. Set the SENSITIVITY switch to the positions indicated in Table 6-4 and adjust the corresponding capacitors for the best square-wave response.

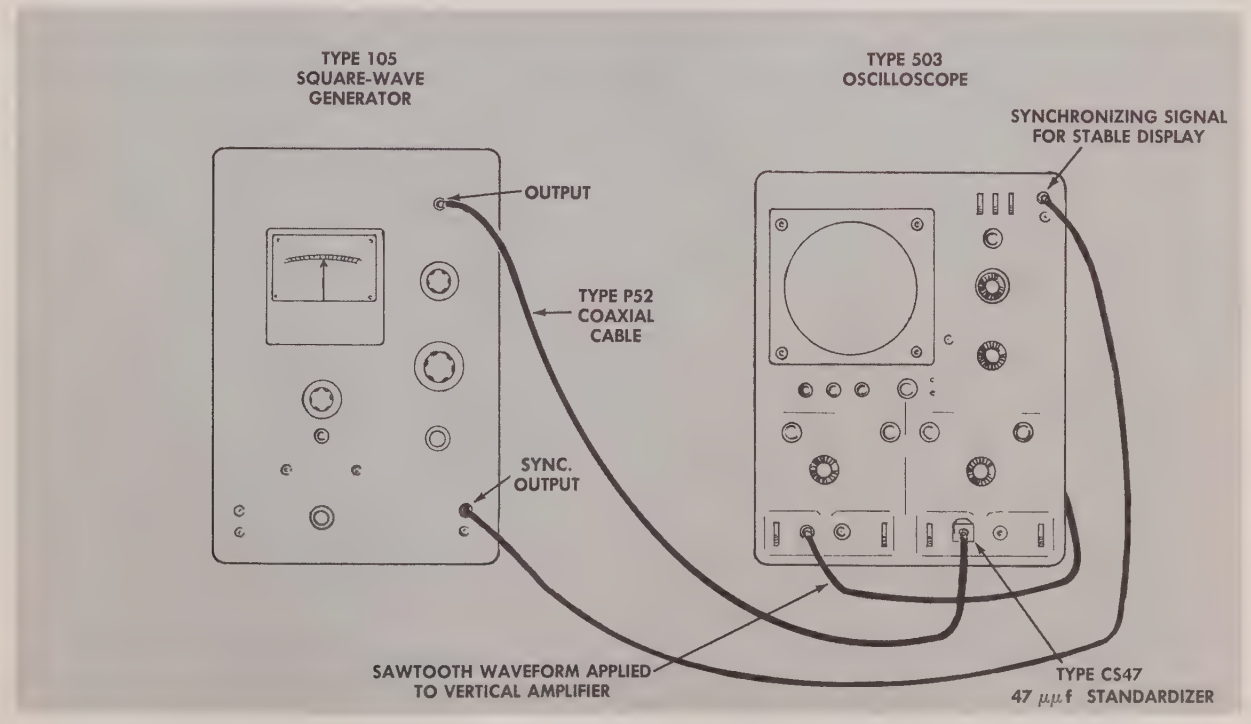


Fig. 6-4. Tektronix Type 105 Square-Wave Generator connected for high-frequency compensation of the Type 503 Oscilloscope Horizontal Amplifier.

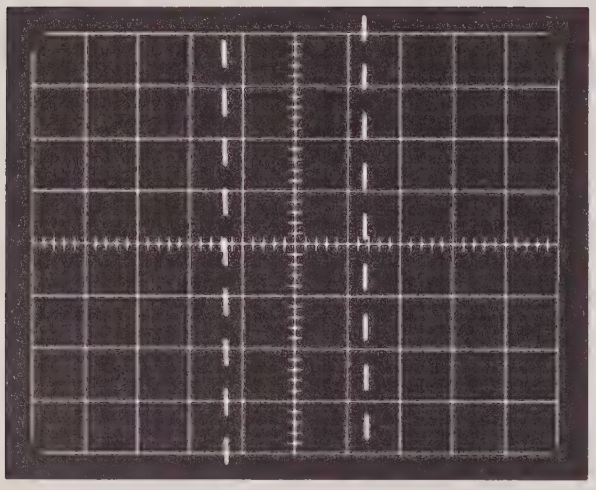


Fig. 6-5. Triggered vertical sweep.

TABLE 6-4	
SENSITIVITY	ADJUST
.2 VOLTS/CM	C316
.5 VOLTS/CM	C315B, C315C
5 VOLTS/CM	C314B, C314C

Disconnect the square-wave generator and the two jumper wires from the Type 503 Oscilloscope.

Sweep Generator

Set the front panel controls as follows:

SLOPE	+
COUPLING	AC
SOURCE	INT.
LEVEL	AUTO.
SWEEP TIME/CM	1 mSEC
VARIABLE*	CALIBRATED
HORIZONTAL DISPLAY	SWEEP NORMAL (X1)
VERTICAL	
+INPUT	DC
—INPUT	GND

*Make sure the SWEEP TIME/CM VARIABLE control is in the CALIBRATED position during all timing adjustments.

16. SWP. CAL. Apply 1-millisecond markers from the time-marker generator to the +INPUT connector of the Vertical Amplifier. Set the FOCUS, INTENSITY, POSITION, and VERTICAL SENSITIVITY controls for best presentation. Adjust the SWP. CAL. control (R322) for one marker per centimeter. (Use the HORIZONTAL POSITION control to align the markers with the graticule lines.) All sweep timing measurements in this and following steps should be made between the 1-centimeter and 9-centimeter graticule lines.

17. SWP. LENGTH. With 1-millisecond markers applied to the Vertical Amplifier, adjust the SWP. LENGTH control (R176) for a sweep length of 10.5 centimeters.

18. SWP./MAG. REGISTER. Set the HORIZONTAL DISPLAY switch to the X50 position and adjust the HORIZONTAL POSITION control to align the first marker with the center of the graticule. Then set the HORIZONTAL DISPLAY switch to the X1 position and adjust the SWP./MAG. REGIS. control (R339) to again align the first marker with the center of the graticule. Repeat this step until the marker remains horizontally centered as the HORIZONTAL DISPLAY switch is changed from X50 to X1.

19. Check Sweep Timing—5 seconds/cm to .1 millisecond/cm. This step checks the accuracy of the sweep-timing components for sweep rates between 5 seconds per centimeter and .1 millisecond per centimeter. There are no adjustments to be made. Table 6-5 lists the time markers to be applied for the indicated settings of the SWEEP TIME/CM switch and the number of markers per centimeter to be observed for each setting. When checking sweep rates between .1 SEC to 5 SEC, it will be necessary to adjust the LEVEL control for a stable display.

TABLE 6-5		
SWEEP TIME/CM	TIME MARKERS	OBSERVE
.1 mSEC	100-μsec	1 marker/cm
1 mSEC	1-msec	1 marker/cm
2 mSEC	1-msec	2 marker/cm
5 mSEC	5-msec	1 marker/cm
10 mSEC	10-msec	1 marker/cm
.1 SEC	100-msec	1 marker/cm
1 SEC	1-sec	1 marker/cm
2 SEC	1-sec	2 marker/cm
5 SEC	5-sec	1 marker/cm

20. Adjust Sweep Timing—10 microseconds/cm. Apply 10-μsec markers from the time-mark generator to the +INPUT connector. Set the SWEEP TIME/CM control to the 10 μSEC position. Check to see that the SWEEP TIME/CM VARIABLE control is in the CALIBRATED position. Adjust the LEVEL control as required to obtain a stable display. Adjust C160C for 1 marker per centimeter on the crt screen.

21. Adjust Sweep Timing—1 microsecond/cm. Apply 1-μsec markers from the time-marker generator to the +INPUT connector. Set the SWEEP TIME/CM control to 1 μSEC position. Adjust the LEVEL, SENSITIVITY, and POSITION controls as required to obtain a stable display. Adjust C160A for 1 marker per centimeter on the crt screen. Disconnect the time-marker generator and replace the side covers.

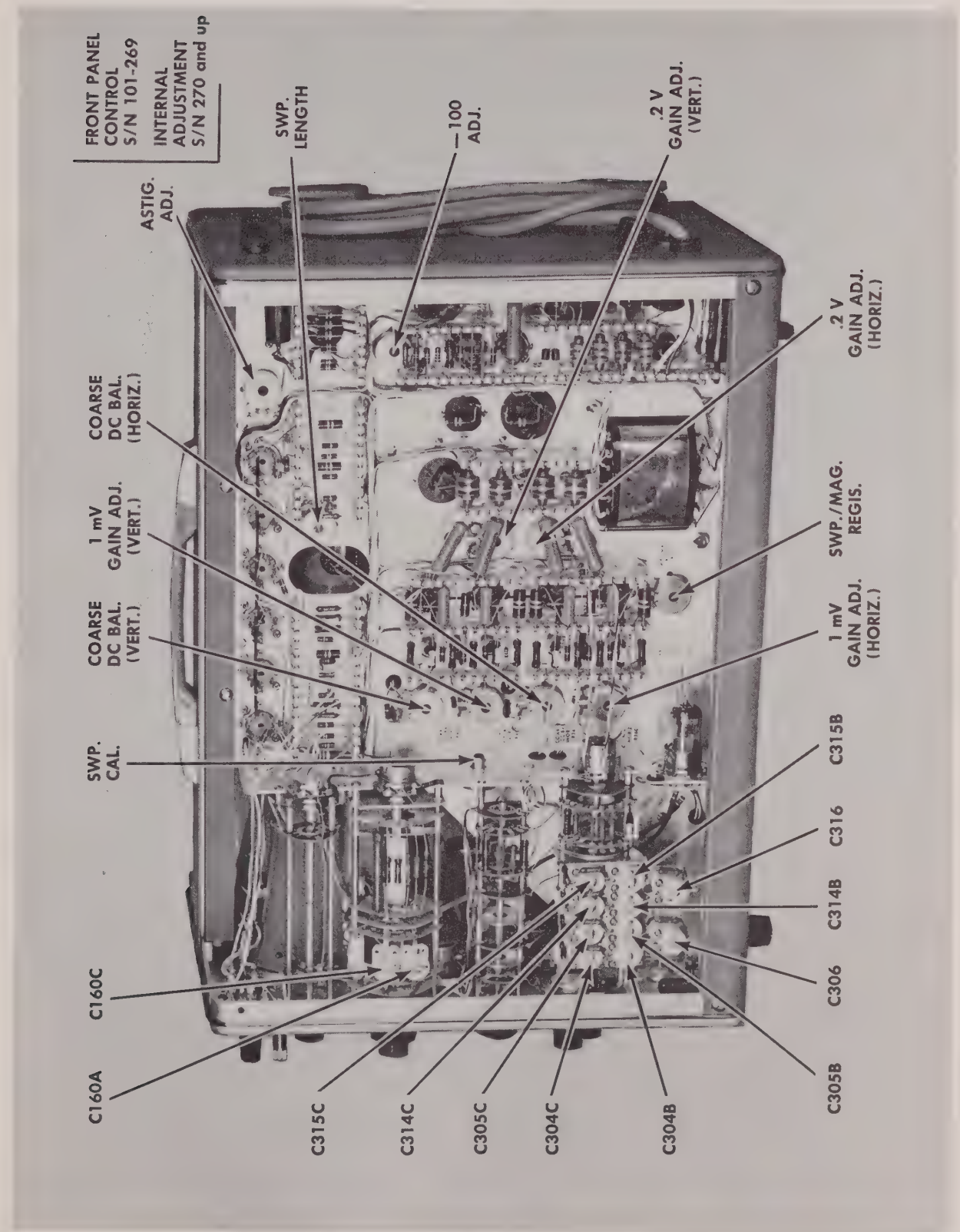


Fig. 6-6. Left side of the Type 503 showing location of internal adjustments.

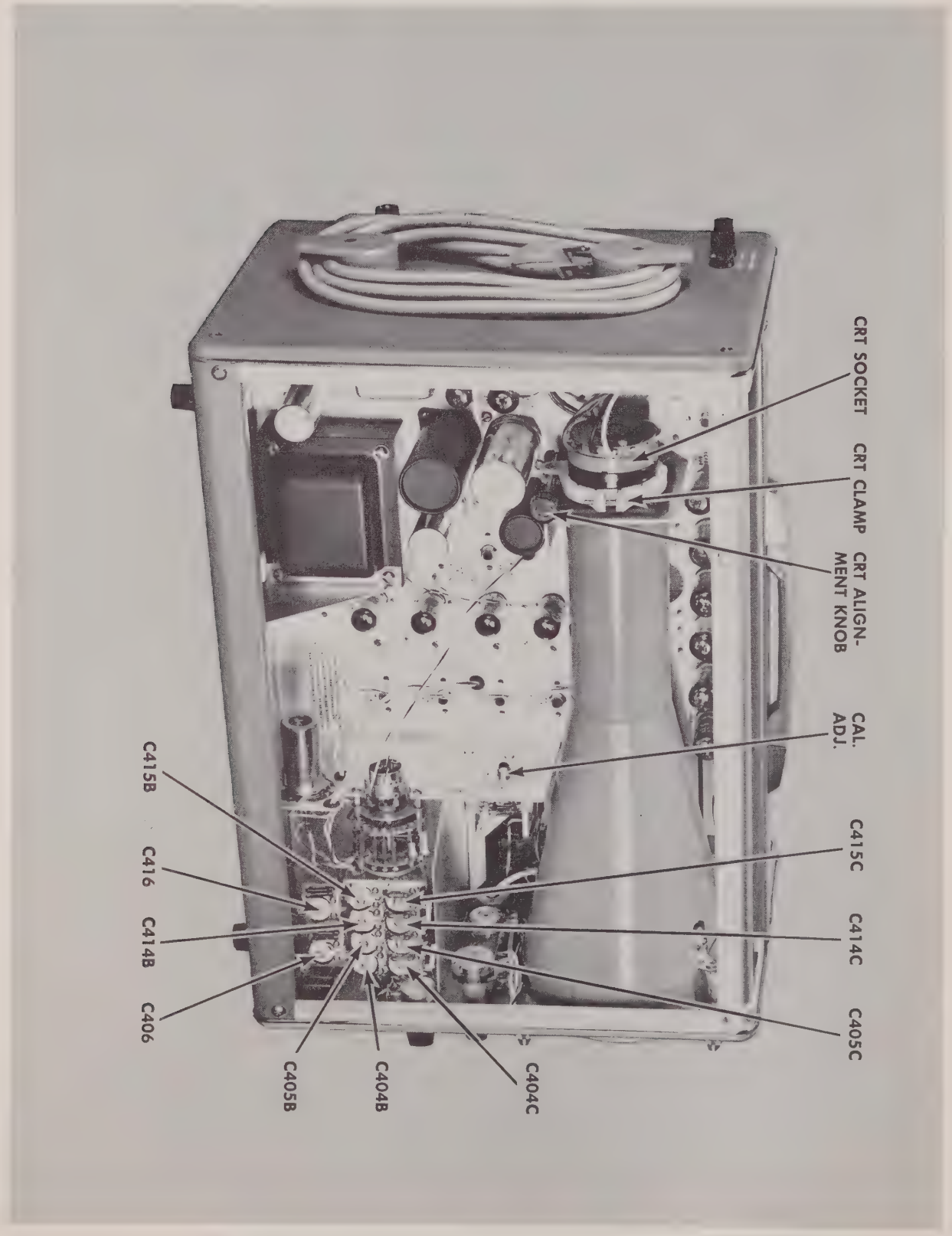
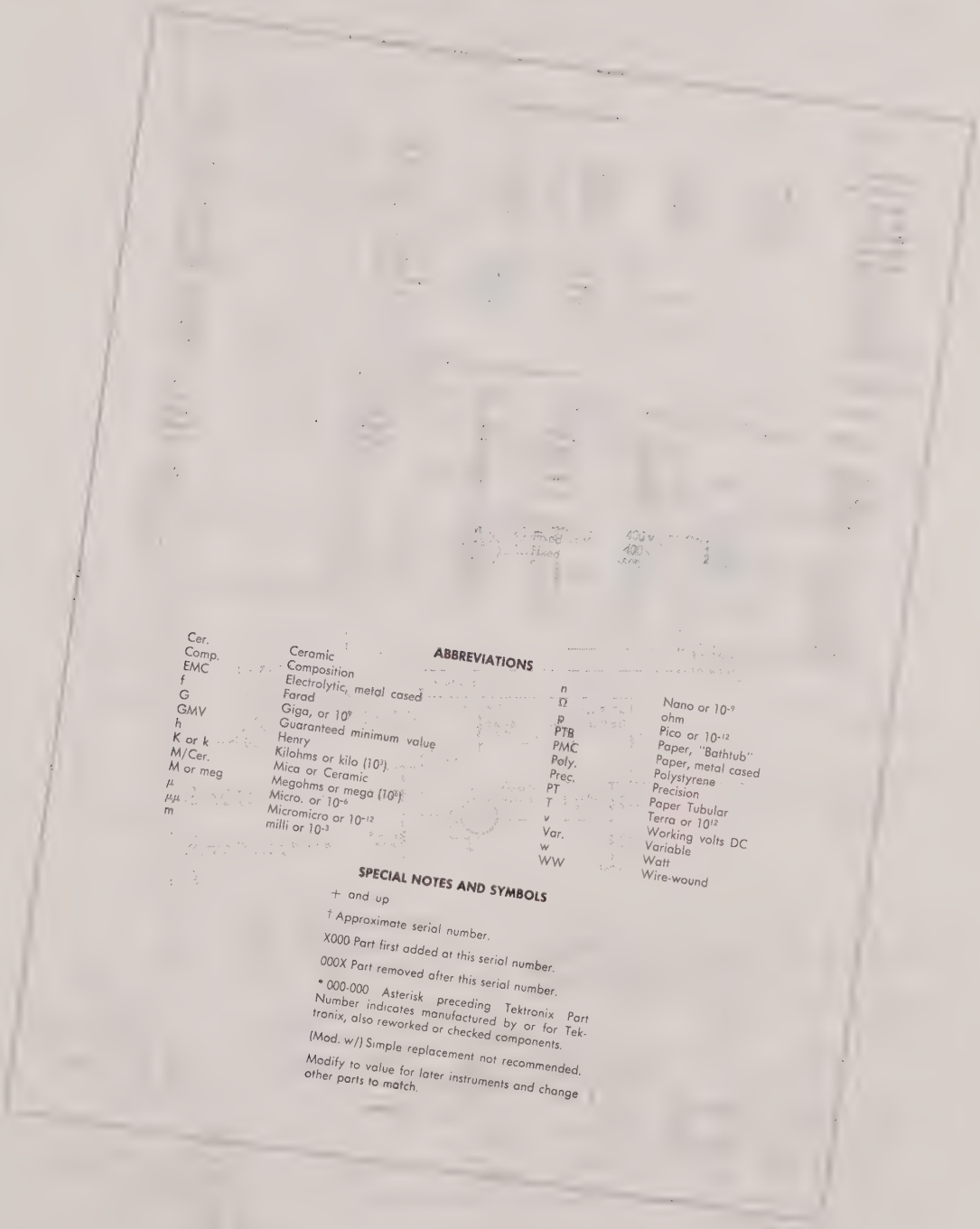


Fig. 6-7. Right side of the Type 503 showing location of internal adjustments.

PARTS LIST *and* DIAGRAMS



ABBREVIATIONS

Cer.	Ceramic	n	Nano or 10^{-9}
Comp.	Composition	Ω	ohm
EMC	Electrolytic, metal cased	p	Pico or 10^{-12}
f	Farad	PTB	Paper, "Bathtub"
G	Giga, or 10^{9}	PMC	Paper, metal cased
GMV	Guaranteed minimum value	Poly.	Polystyrene
h	Henry	Prec.	Precision
K or k	Kilohms or kilo (10^{3})	PT	Paper Tubular
M/Cer.	Mica or Ceramic	T	Terra or 10^{12}
M or meg	Megohms or mega (10^{6})	v	Working volts DC
μ	Micro. or 10^{-6}	Var.	Variable
μμ	Micromicro or 10^{-12}	w	Watt
m	milli or 10^{-3}	WW	Wire-wound

SPECIAL NOTES AND SYMBOLS

+ and up

† Approximate serial number.

X000 Part first added at this serial number.

000X Part removed after this serial number.

* 000-000 Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, also reworked or checked components.

(Mod. w/) Simple replacement not recommended. Modify to value for later instruments and change other parts to match.

MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

HOW TO ORDER PARTS

Replacement parts are available through your local Tektronix Field Office.

Improvements in Tektronix instruments are incorporated as soon as available. Therefore, when ordering a replacement part it is important to supply the part number including any suffix, instrument type, serial number, plus a modification number where applicable.

If the part you have ordered has been improved or replaced, your local Field Office will contact you if there is a change in part number.

PARTS LIST

*000-000 asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, also reworked or checked components.

Bulbs

		Tektronix Part Number
B167	Neon, Type NE-2	150-002
B601	Incandescent, #47	150-001
B602	Incandescent, #47	150-001
B883	Neon, Type NE-2, Checked	Use *150-009
B886	Neon, Type NE-2, Checked	Use *150-009

Fuses

F601	1.25 amp 3 AG Slo Blo	117 v operation 50 & 60 cycles	159-041
F601	.7 amp 3 AG Slo-Blo	234 v aperation 50 & 60 cycles	159-040

Capacitors

C10		.005 μf	Cer.	Fixed	500 v		283-001
C15		.001 μf	Cer.	Fixed	500 v		283-000
C20		.001 μf	Cer.	Fixed	500 v		283-000
C31		.01 μf	Cer.	Fixed	500 v		283-002
C37		22 μμf	Cer.	Fixed	500 v		281-510
C43		47 μμf	Cer.	Fixed	500 v		281-518
C131		22 μμf	Cer.	Fixed	500 v	10%	281-511
C141		4.7 μμf	Cer.	Fixed	500 v	±1 μμf	281-501
C160A		3-12 μμf	Cer.	Var.			281-007
C160B	101-809	82 μμf	Cer.	Fixed	500 v		Use 281-574
C160B	810-up	82 μμf	Cer.	Fixed	500 v	10%	281-574
C160C		4.5-25 μμf	Cer.	Var.			281-010
C160D		.001 μf		Fixed		±½%	*291-008
C160E		.01 μf					
C160F		.1 μf		Fixed		Timing Series ±½%	*291-029
C160G		1 μf					
C167		.001 μf	Cer.	Fixed	500 v		283-000
C181	X400-up	15 μμf	Cer.	Fixed	500 v	±1.5 μμf	281-509
C300 †		.022 μf	PTM	Fixed	600 v	Selected	*295-063
C304B		7-45 μμf	Cer.	Var.			281-012
C304C		1.5-7 μμf	Cer.	Var.			281-005
C304E		198 μμf	Cer.	Fixed	500 v	10%	281-560
C305B		7-45 μμf	Cer.	Var.			281-012
C305C		1.5-7 μμf	Cer.	Var.			281-005
C306		3-12 μμf	Cer.	Var.			281-007
C308A	X1270-up	8 μμf	Cer.	Fixed	500 v	±0.5 μμf	281-503
C308C	X1270-up	18 μμf	Cer.	Fixed	500 v	10%	281-542

† C300, C310, C400 & C410 selected ±5% each other, furnished as a unit.

Capacitors *(continued)*

							Tektronix Part Number
C308E	X1621-2169X	47 μμf	Cer.	Fixed	500 v	5%	281-583
C308G	X1621-2169X	100 μμf	Cer.	Fixed	500 v	5%	281-584
C308J	X1621-2169X	270 μμf	Cer.	Fixed	500 v	5%	281-585
C308L	101-559X	470 μμf	Cer.	Fixed	500 v		281-525
C308L	X1621-2169X	750 μμf	Mica	Fixed	500 v	5%	283-524
C308N	101-559	1800 μμf	Cer.	Fixed	500 v	10%	281-561
C308N	X1621-2169X	2000 μμf	Mica	Fixed	500 v	1%	283-555
C310 †		.022 μf	PTM	Fixed	600 v	Selected	*295-063
C314B		7-45 μμf	Cer.	Var.			281-012
C314C		1.5-7 μμf	Cer.	Var.			281-005
C314E		198 μμf	Cer.	Fixed	500 v	10%	281-560
C315B		7-45 μμf	Cer.	Var.			281-012
C315C		1.5-7 μμf	Cer.	Var.			281-005
C316		3-12 μμf	Cer.	Var.			281-007
C330		.005 μf	Cer.	Fixed	500 v		283-001
C336		.005 μf	Cer.	Fixed	500 v		283-001
C340		.005 μf	Cer.	Fixed	500 v		283-001
C346		.005 μf	Cer.	Fixed	500 v		283-001
C350		47 μμf	Cer.	Fixed	500 v		281-518
C353		.1 μf	Cer.	Fixed	200 v		Use 283-057
C356	101-559	2.2 μμf	Cer.	Fixed	500 v		281-500
C356	560-up	1.5-7 μμf	Cer.	Var.			281-029
C357	101-2169	18 μμf	Cer.	Fixed	500 v		281-542
C357	2170-up	12 μμf	Cer.	Fixed	500 v		281-505
C360		47 μμf	Cer.	Fixed	500 v		281-518
C366	101-2169X	2.2 μμf	Cer.	Fixed	500 v	±.5 μμf	281-500
C367	101-2169	18 μμf	Cer.	Fixed	500 v	10%	281-542
C367	2170-up	12 μμf	Cer.	Fixed	500 v	10%	281-505
C390		1 μμf	Cer.	Fixed	500 v		281-538
C400 †		.022 μf	PTM	Fixed	600 v	Selected	*295-063
C404B		7-45 μμf	Cer.	Var.			281-012
C404C		1.5-7 μμf	Cer.	Var.			281-005
C404E		198 μμf	Cer.	Fixed	500 v	10%	281-560
C405B		7-45 μμf	Cer.	Var.			281-012
C405C		1.5-7 μμf	Cer.	Var.			281-005
C406		4.5-25 μμf	Cer.	Var.			281-010
C408A	X1270-up	8 μμf	Cer.	Fixed	500 v	±0.5 μμf	281-503
C408C	X1270-up	18 μμf	Cer.	Fixed	500 v	10%	281-542
C408E	X1621-2169X	47 μμf	Cer.	Fixed	500 v	5%	281-583
C408G	X1621-2169X	100 μμf	Cer.	Fixed	500 v	5%	281-584
C408J	X1621-2169X	270 μμf	Cer.	Fixed	500 v	5%	281-585
C408L	101-559X	470 μμf	Cer.	Fixed	500 v		281-525
C408L	X1621-2169X	750 μμf	Mica	Fixed	500 v	5%	283-524
C408N	101-559X	1800 μμf	Cer.	Fixed	500 v	10%	281-561
C408N	X1621-2169X	2000 μμf	Mica	Fixed	500 v	1%	283-555
C410†		.022 μf	PTM	Fixed	600 v	Selected	*295-063
C414B		7-45 μμf	Cer.	Var.			281-012
C414C		1.5-7 μμf	Cer.	Var.			281-005
C414E		198 μμf	Cer.	Fixed	500 v	10%	281-560
C415B		7-45 μμf	Cer.	Var.			281-012
C415C		1.5-7 μμf	Cer.	Var.			281-005

† Note: C300 & C310 selected ±5% each other, furnished as a unit.
C400 & C410 selected ±5% each other, furnished as a unit.

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Capacitors *(continued)*

							Tektronix Part Number
C416		7-45 μμf	Cer.	Var.			Use 281-012
C419	X560-up	3-12 μμf	Cer.	Var.			Use 281-007
C430		.005 μf	Cer.	Fixed	500 v		283-001
C436		.005 μf	Cer.	Fixed	500 v		283-001
C440		.005 μf	Cer.	Fixed	500 v		283-001
C446		.005 μf	Cer.	Fixed	500 v		283-001
C450		47 μμf	Cer.	Fixed	500 v		281-518
C453		.1 μf	Cer.	Fixed	200 v		Use 283-057
C456	101-559	2.2 μμf	Cer.	Fixed	500 v		281-500
C456	560-up	1.5-7 μμf	Cer.	Var.			281-029
C457	101-2169	18 μμf	Cer.	Fixed	500 v	10%	281-542
C457	2170-up	12 μμf	Cer.	Fixed	500 v	10%	281-505
C460		47 μμf	Cer.	Fixed	500 v		281-518
C466	101-2169X	2.2 μμf	Cer.	Fixed	500 v	±.5 μμf	281-500
C467	101-2169	18 μμf	Cer.	Fixed	500 v	10%	281-542
C467	2170-up	12 μμf	Cer.	Fixed	500 v	10%	281-505
C605		.05 μf	Cer.	Fixed	50 v		Use 283-010
C611		125 μf	EMC	Fixed	350 v		*290-052
C612		125 μf	EMC	Fixed	350 v		*290-044
C614	X1440-up	.02 μf	Cer.	Fixed	1400 v		283-022
C620		.01 μf	Mica	Fixed	600 v	5%	Use 283-575
C621		.005 μf	Cer.	Fixed	500 v		283-001
C624	X1210-up	10 μf	EMC	Fixed	15 v		290-106
C628		.001 μf	Cer.	Fixed	500 v		283-000
C629	X2660-up	.001 μf	Discap.	Fixed	500 v		283-000
C630		.001 μf	Cer.	Fixed	500 v		283-000
C642		.005 μf	Cer.	Fixed	500 v		283-001
C646		.01 μf	Cer.	Fixed	500 v		283-002
C652A		10 μf	EMC	Fixed	350 v		
C652B		50 μf	EMC	Fixed	150 v		*290-127
C652C		100 μf	EMC	Fixed	50 v		
C654A		10 μf	EMC	Fixed	350 v		
C654B		50 μf	EMC	Fixed	150 v		*290-127
C654C		100 μf	EMC	Fixed	50 v		
C682		2 x 10 μf	EMC	Fixed	250 v		*290-128
C684		2 x 40 μf	EMC	Fixed	150 v		*290-039
C692A,B		.005 μf	Cer.	Fixed	4000 v		Use 283-034
C851A,B		.005 μf	Cer.	Fixed	4000 v		Use 283-034
C854		.001 μf	Cer.	Fixed	6000 v		283-033
C858		.005 μf	Cer.	Fixed	500 v		283-001
C883		.0022 μf	PTM	Fixed	400 v		285-543
C886	X2215-up	.0022 μf	Discap.	Fixed	50 v		283-028

Inductors

L319	101-559	3.9 mh	Fixed		108-204
L319	560-up	4.7 mh	Fixed		*108-165
L373	101-869	3.9 mh	Fixed		Use 108-224
L373	870-up	3.9 mh	Fixed		108-224
L383	101-869	3.9 mh	Fixed		Use 108-224

Inductors *(continued)*

				Tektronix Part Number
L383	870-up	3.9 mh	Fixed	108-224
L419	101-559	3.9 mh	Fixed	108-204
L419	560-up	4.7 mh	Fixed	108-165
L473		3.9 mh	Fixed	Use 108-224
L483	101-869	3.9 mh	Fixed	Use 108-224
L483	870-up	3.9 mh	Fixed	108-224
L654		1 mh	Fixed	108-207
L664		1 mh	Fixed	108-207
L672		1 mh	Fixed	108-205
L684		1 mh	Fixed	108-207

Resistors

R14		1 meg	½ w	Fixed	Comp.	10%	302-105
R15		470 k	½ w	Fixed	Comp.	10%	302-474
R17		1 meg		Var.	Comp.	30%	311-184
R19		2.2 meg	½ w	Fixed	Comp.	10%	302-225
R20		270 k	½ w	Fixed	Comp.	10%	302-274
R22		470 Ω	½ w	Fixed	Comp.	10%	302-471
R23		470 Ω	½ w	Fixed	Comp.	10%	302-471
R25		27 k	½ w	Fixed	Comp.	10%	302-273
R26	101-2199	100 k	½ w	Fixed	Comp.	10%	302-104
R26	2200-up	120 k	½ w	Fixed	Prec.	1%	309-091
R28	101-2199	33 k	1 w	Fixed	Comp.	10%	304-333
R28	2200-up	33 k	1 w	Fixed	Prec.	1%	310-070
R34		680 Ω	½ w	Fixed	Comp.	10%	302-681
R35		2.7 k	½ w	Fixed	Comp.	10%	302-272
R36	X870-up	470 Ω	½ w	Fixed	Comp.	10%	302-471
R37		370 k	½ w	Fixed	Prec.	1%	309-055
R38		500 k	½ w	Fixed	Prec.	1%	309-003
R40		2.7 meg	½ w	Fixed	Comp.	10%	302-275
R43		4.7 k	½ w	Fixed	Comp.	10%	302-472
R44		10 k	½ w	Fixed	Comp.	10%	302-103
R46		22 k	1 w	Fixed	Comp.	10%	304-223
R111		15 k		Var.	Comp.	20%	311-112
R112	101-269	27 k	½ w	Fixed	Comp.	10%	302-273
R112	270-up	27 k	½ w	Fixed	Comp.	5%	301-273
R113	101-269	56 k	½ w	Fixed	Comp.	10%	302-563
R113	270-up	51 k	½ w	Fixed	Comp.	5%	301-513
R134		82 k	½ w	Fixed	Prec.	1%	309-043
R135		180 k	½ w	Fixed	Comp.	5%	301-184
R137		100 Ω	½ w	Fixed	Comp.	10%	302-101
R141		100 k	½ w	Fixed	Prec.	1%	309-045
R143		25.6 k	½ w	Fixed	Prec.	1%	309-136
R144		20 k	½ w	Fixed	Prec.	1%	309-153
R146		100 Ω	½ w	Fixed	Comp.	10%	302-101
R147		1.5 k	½ w	Fixed	Comp.	10%	302-152
R160A		1 meg	½ w	Fixed	Prec.	1%	309-014
R160B		2 meg	½ w	Fixed	Prec.	1%	309-023
R160C		5 meg	½ w	Fixed	Prec.	1%	309-087
R160D		10 meg	½ w	Fixed	Prec.	1%	309-095
R160E		10 meg	½ w	Fixed	Prec.	1%	309-095
R160F		30 meg	2 w	Fixed	Prec.	1%	310-505

							Tektronix Part Number
R160X		82 k	½ w	Fixed	Comp.	10%	302-823
R160Y		200 k		Var.	Comp.	20%	311-182
R164		150 k	1 w	Fixed	Comp.	10%	304-154
R167		1 meg	½ w	Fixed	Comp.	10%	302-105
R168		100 k	½ w	Fixed	Comp.	10%	302-104
R171		100 Ω	½ w	Fixed	Comp.	10%	302-101
R174		27 k	1 w	Fixed	Comp.	10%	304-273
R176		5 k	½ w	Var.	Comp.	20%	Use 311-368
R178		8.2 k	½ w	Fixed	Comp.	10%	302-822
R181		4.7 meg	½ w	Fixed	Comp.	10½	302-475
R304C		990 k	½ w	Fixed	Prec.	1%	309-145
R304E		10.1 k	⅛ w	Fixed	Prec.	1%	318-009
R305C		900 k	½ w	Fixed	Prec.	1%	309-142
R305E		111 k	⅛ w	Fixed	Prec.	1%	318-006
R306		1 meg	½ w	Fixed	Prec.	1%	309-014
R308A		10 k	½ w	Fixed	Prec.	1%	309-100
R308C		3.33 k	½ w	Fixed	Prec.	1%	309-283
R308E		1.11 k	½ w	Fixed	Prec.	1%	309-284
R308G		526 Ω	½ w	Fixed	Prec.	1%	309-285
R308J		256 Ω	½ w	Fixed	Prec.	1%	309-286
R308L		101 Ω	½ w	Fixed	Prec.	1%	309-287
R308N	101-869	50 Ω	½ w	Fixed	Prec.	1%	309-128
R308N	870-up	50.9 Ω	½ w	Fixed	Prec.	1%	309-216
R314C		990 k	½ w	Fixed	Prec.	1%	309-145
R314E		10.1 k	⅛ w	Fixed	Prec.	1%	318-009
R315C		900 k	½ w	Fixed	Prec.	1%	309-142
R315E		111 k	⅛ w	Fixed	Prec.	1%	318-006
R316		1 meg	½ w	Fixed	Prec.	1%	309-014
R318A		10 k	½ w	Fixed	Prec.	1%	309-100
R318C		2.5 k	½ w	Fixed	Prec.	1%	309-181
R318E		1.11 k	½ w	Fixed	Prec.	1%	309-284
R318G		526 Ω	½ w	Fixed	Prec.	1%	309-285
R318J		204 Ω	½ w	Fixed	Prec.	1%	309-237
R319		21.5 k	½ w	Fixed	Prec.	1%	309-290
R320		193 k	½ w	Fixed	Prec.	1%	309-243
R321		3.92 k	½ w	Fixed	Prec.	1%	309-270
R322		500 Ω	½ w	Var.	Comp.	20%	Use 311-362
R326		4.7 meg	½ w	Fixed	Comp.	10%	302-475
R327		180 k	½ w	Fixed	Comp.	5%	Use 301-184
R330		100 k	½ w	Fixed	Comp.	10%	302-104
R331		470 Ω	½ w	Fixed	Comp.	10%	302-471
R334		50 k	½ w	Fixed	Prec.	1%	309-090
R336		250 Ω	½ w	Var.	Comp.	20%	311-181
R337		68 Ω	½ w	Fixed	Comp.	10%	302-680
R338		38.3 k	1 w	Fixed	Prec.	1%	310-074
R339		1 k	½ w	Var.	Comp.	20%	Use 311-365
R340		100 k	½ w	Fixed	Comp.	10%	302-104
R341		470 Ω	½ w	Fixed	Comp.	10%	302-471
R344		50 k	½ w	Fixed	Prec.	1%	309-090
R346		250 Ω	½ w	Var.	Comp.	20%	Use 311-367

							Tektronix Part Number
R347		68 Ω	½ w	Fixed	Comp.	10%	302-680
R348		38.3 k	1 w	Fixed	Prec.	1%	310-074
R350		1.5 k	½ w	Fixed	Comp.	10%	302-152
R352		8.2 k	1 w	Fixed	Comp.	5%	303-822
R353	101-1269	10 k	½ w	Fixed	Comp.	5%	301-103
R353	1270-2169	6.8 k	½ w	Fixed	Comp.	5%	301-682
R353	2170-up	10 k	½ w	Fixed	Comp.	5%	301-103
R354	X1270-2169X	3.3 k	½ w	Fixed	Comp.	5%	301-332
R356		390 k	¼ w	Fixed	Comp.	10%	316-394
R357		12.5 k	½ w	Fixed	Prec.	1%	309-228
R358		1 meg	½ w	Fixed	Comp.	10%	302-105
R360		20 k	½ w	Var.	Comp.	20%	Use 311-364
R366		390 k	¼ w	Fixed	Comp.	10%	316-394
R367		12.5 k	½ w	Fixed	Prec.	1%	309-228
R368		1 meg	½ w	Fixed	Comp.	10%	302-105
R370		2 x 20 k		Var.	Comp.	20%	311-190
R371		100 Ω	½ w	Fixed	Comp.	10%	302-101
R373		30 k	8 w	Fixed	WW	5%	308-105
R376		15 k	5 w	Fixed	WW	5%	308-108
R377		12 k	2 w	Fixed	Comp.	10%	306-123
R378	101-809	2 k		Var.	Comp.	30%	Use 311-363
R378	810-up	1 k	½ w	Var.	Comp.	20%	Use 311-365
R379	X810-up	402 Ω	½ w	Fixed	Prec.	1%	309-102
R381		100 Ω	½ w	Fixed	Comp.	10%	302-101
R383		30 k	8 w	Fixed	WW	5%	308-105
R386		15 k	5 w	Fixed	WW	5%	308-108
R387		12 k	2 w	Fixed	Comp.	10%	306-123
R388		2.5 k	½ w	Var.	WW	20%	Use 311-375
R404C		990 k	½ w	Fixed	Prec.	1%	309-145
R404E		10.1 k	⅛ w	Fixed	Prec.	1%	318-009
R405C		900 k	½ w	Fixed	Prec.	1%	309-142
R405E		111 k	⅛ w	Fixed	Prec.	1%	318-006
R406		1 meg	½ w	Fixed	Prec.	1%	309-014
R408A		10 k	½ w	Fixed	Prec.	1%	309-100
R408C		3.33 k	½ w	Fixed	Prec.	1%	309-283
R408E		1.11 k	½ w	Fixed	Prec.	1%	309-284
R408G		526 Ω	½ w	Fixed	Prec.	1%	309-285
R408J		256 Ω	½ w	Fixed	Prec.	1%	309-286
R408L		101 Ω	½ w	Fixed	Prec.	1%	309-287
R408N	101-869	50 Ω	½ w	Fixed	Prec.	1%	309-128
R408N	870-up	50.9 Ω	½ w	Fixed	Prec.	1%	309-216
R414C		990 k	½ w	Fixed	Prec.	1%	309-145
R414E		10.1 k	⅛ w	Fixed	Prec.	1%	318-009
R415C		900 k	½ w	Fixed	Prec.	1%	309-142
R415E		111 k	⅛ w	Fixed	Prec.	1%	318-006
R416		1 meg	½ w	Fixed	Prec.	1%	309-014
R419		21.5 k	½ w	Fixed	Prec.	1%	309-290
R430		100 k	½ w	Fixed	Comp.	10%	302-104

Resistors *(continued)*

							Tektronix Part Number
R431		470 Ω	½ w	Fixed	Comp.	10%	302-471
R434		50 k	½ w	Fixed	Prec.	1%	309-090
R436		250 Ω	½ w	Var.	Comp.	20%	Use 311-367
R437		68 Ω	½ w	Fixed	Comp.	10%	302-680
R438		38.3 k	1 w	Fixed	Prec.	1%	310-074
R440		100 k	½ w	Fixed	Comp.	10%	302-104
R441		470 Ω	½ w	Fixed	Comp.	10%	302-471
R444		50 k	½ w	Fixed	Prec.	1%	309-090
R446		250 Ω		Var.	Comp.	20%	311-181
R447		68 Ω	½ w	Fixed	Comp.	10%	302-680
R448		38.3 k	1 w	Fixed	Prec.	1%	310-074
R450		1.5 k	½ w	Fixed	Comp.	10%	302-152
R451	X2170-up	470 Ω	½ w	Fixed	Comp.	10%	302-471
R452		8.2 k	1 w	Fixed	Comp.	5%	303-822
R453	101-1269	10 k	½ w	Fixed	Comp.	5%	301-103
R453	1270-2169	6.8 k	½ w	Fixed	Comp.	5%	301-682
R453	2170-up	10 k	½ w	Fixed	Comp.	5%	301-103
R454	X1270-2169X	3.3 k	½ w	Fixed	Comp.	5%	301-332
R455	X2170-up	18 k	1 w	Fixed	Comp.	10%	304-183
R456		390 k	¼ w	Fixed	Comp.	10%	316-394
R457		12.5 k	½ w	Fixed	Prec.	1%	309-228
R458		1 meg	½ w	Fixed	Comp.	10%	302-105
R460		20 k	½ w	Var.	Comp.	20%	Use 311-364
R466		390 k	¼ w	Fixed	Comp.	10%	316-394
R467		12.5 k	½ w	Fixed	Prec.	1%	309-228
R468		1 meg	½ w	Fixed	Comp.	10%	302-105
R470		2 x 20 k		Var.	Comp.	20%	311-190
R471		100 Ω	½ w	Fixed	Comp.	10%	302-101
R473		30 k	8 w	Fixed	WW	5%	308-105
R476		15 k	5 w	Fixed	WW	5%	308-108
R477		12 k	2 w	Fixed	Comp.	10%	306-123
R478	101-809	2 k		Var.	Comp.	30%	Use 311-363
R478	810-up	750 Ω	½ w	Var.	Comp.	20%	Use 311-372
R479	X810-up	402 Ω	½ w	Fixed	Prec.	1%	309-102
R481		100 Ω	½ w	Fixed	Comp.	10%	302-101
R483		30 k	8 w	Fixed	WW	5%	308-105
R486		15 k	5 w	Fixed	WW	5%	308-108
R487		12 k	2 w	Fixed	Comp.	10%	306-123
R488		2 k		Var.	Comp.	20%	311-189
R490		470 k	½ w	Fixed	Comp.	10%	302-474
R491		47 k	½ w	Fixed	Comp.	10%	302-473
R492		330 k	½ w	Fixed	Comp.	10%	302-334
R601†		50 Ω		Var.	WW		311-057
R605		47 k	½ w	Fixed	Comp.	10%	302-473
R606	X1100-up	100 Ω	½ w	Fixed	Comp.	10%	302-101
R607	X1100-up	100 Ω	½ w	Fixed	Comp.	10%	302-101
R611		150 k	1 w	Fixed	Comp.	10%	304-154
R612		150 k	1 w	Fixed	Comp.	10%	304-154
R621		100 k	½ w	Fixed	Comp.	10%	302-104
R623		4.7 k	½ w	Fixed	Comp.	10%	302-472

† R601 ganged with SW601. Furnished as a unit.

Resistors *(continued)*

							Tektronix Part Number
R624	X1210-up	22 Ω	½ w	Fixed	Comp.	10%	302-220
R626		40 k	8 w	Fixed	WW	5%	308-168
R628		470 Ω	½ w	Fixed	Comp.	10%	302-471
R630		680 k	½ w	Fixed	Comp.	10%	302-684
R631		2.2 meg	½ w	Fixed	Comp.	10%	302-225
R632		100 Ω	½ w	Fixed	Comp.	10%	302-101
R634		33 k	½ w	Fixed	Comp.	10%	302-333
R635		56 k	½ w	Fixed	Comp.	10%	302-563
R637		470 k	½ w	Fixed	Comp.	10%	302-474
R640		154 k	½ w	Fixed	Prec.	1%	309-234
R641		20 k	½ w	Var.	Comp.	20%	Use 311-364
R642		174 k	½ w	Fixed	Prec.	1%	309-151
R644		470 k	½ w	Fixed	Comp.	10%	302-474
R646		15 k	½ w	Fixed	Comp.	10%	302-153
R659		100 k	½ w	Fixed	Comp.	10%	302-104
R692		4.3 Ω	½ w	Fixed	Comp.	5%	307-056
R840		820 k	1 w	Fixed	Comp.	10%	304-824
R841		820 k	1 w	Fixed	Comp.	10%	304-824
R842		820 k	1 w	Fixed	Comp.	10%	304-824
R844		1 meg		Var.	Comp.		311-041
R845		470 k	½ w	Fixed	Comp.	10%	302-474
R847	101-1209	500 k		Var.	Comp.	20%	311-188
R847	1210-up	200 k		Var.	Comp.	20%	311-242
R849		47 k	½ w	Fixed	Comp.	10%	302-473
R851		1.5 meg	½ w	Fixed	Comp.	10%	302-155
R852	101-1209	2.2 meg	½ w	Fixed	Comp.	10%	302-225
R852	1210-up	1.5 meg	½ w	Fixed	Comp.	10%	302-155
R854		100 k	½ w	Fixed	Comp.	10%	302-104
R857		39 k	½ w	Fixed	Comp.	10%	use 302-393
R858		100 k	½ w	Fixed	Comp.	10%	302-104
R860		220 k	½ w	Fixed	Comp.	10%	302-224
R862		100 k	½ w	Fixed	Comp.	10%	302-104
R864	101-269	500 k		Var.	Comp.	20%	311-183
R864	270-up	500 k	½ w	Var.	Comp.	20%	Use 311-366
R880		500 k	½ w	Var.	Comp.	20%	Use 311-366
R881		1.75 meg	½ w	Fixed	Prec.	1%	309-019
R883		2.2 meg	½ w	Fixed	Comp.	10%	302-225
R886		4.95 k	½ w	Fixed	Prec.	1%	309-239
R887	101-869	50 Ω	½ w	Fixed	Prec.	1%	309-128
R887	870-up	49.5 Ω	½ w	Fixed	Prec.	1%	309-215

Switches

		Wired	Unwired
SW5	single pole triple throw slide SOURCE		*260-251
SW10	single pole double throw slide COUPLING		*260-145
SW17	2 section 11 position rotary TRIG LEVEL	*262-325	*260-322
SW20	double pole double throw slide SLOPE		*260-212
SW160	6 section 21 position rotary TIME/CM	*262-322	*260-320

©I

			Tektronix Part Number	
			Wired	Unwired
SW300		single pole triple throw slide AC/DC +INPUT		*260-316
SW304		6 section 14 position rotary HORIZ. SENS.	Use *262-548	*260-319
SW310		single pole triple throw slide AC/DC —INPUT		*260-316
SW318		6 section 7 position rotary HORIZ. DISPLAY	*262-324	*260-321
SW400		single pole triple throw slide AC/DC —INPUT		*260-316
SW404		6 section 14 position rotary VERT. SENS.	Use *262-526	*260-318
SW410		single pole triple throw slide AC/DC +INPUT		*260-316
SW601†				311-057

Transformers

T601	101-1099	LV Power	*050-039
T601	1100-up	LV Power	*120-203
T620	101-1269	High Voltage	Use *120-199
T620	1270-up	High Voltage	*120-199

Diodes

D44		Germanium, T12-G	152-008
D352	X1270-2659	Germanium, T12-G	152-008
	2660-up	Silicon 1N625	152-095
D362	X1270-2659	Germanium, T12-G	152-008
	2660-up	Silicon 1N625	152-095
D452	X1270-2659	Germanium, T12-G	152-008
	2660-up	Silicon 1N625	152-095
D462	X1270-2659	Germanium, T12-G	152-008
	2660-up	Silicon 1N625	152-095
D611		Silicon, 600 v PIV 500 MA 1N2864	152-048
D612		Silicon, 600 v PIV 500 MA 1N2864	152-048
D652		Silicon, Selected for short recovery time-600 PIV, 500 MA	*153-008
D662		Silicon, Selected for short recovery time-400 PIV, 500 MA	*153-007
D672		Silicon, Selected for short recovery time-400 PIV, 500 MA	*153-007
D682		Silicon, Selected for short recovery time-400 PIV, 500 MA	*153-007

Transistors

Q354	101-2169	3687/2N1637/2N1631	151-045
Q354	2170-up	2N1749	151-081
Q364	101-2169	3687/2N1637/2N1631	151-045
Q364	2170-up	2N1749	151-081
Q454	101-2169	3687/2N1637/2N1631	151-045
Q454	2170-up	2N1749	151-081
Q464	101-2169	3687/2N1637/2N1631	151-045
Q464	2170-up	2N1749	151-081

Electron Tubes

V24	6DJ8	154-187
V45	6DJ8	154-187
V135	6DJ8	154-187
V145	6DJ8	154-187
V152	6BC7	154-232

† SW601 ganged with R601. Furnished as a unit.

Electron Tubes *(continued)*

			Tektronix Part Number
V160	6BL8/ECF80		154-278
V334	6DJ8	checked	use *157-066
V374	6CB6		154-030
V384	6CB6		154-030
V434	6DJ8	checked	use *157-066
V474	6CB6		154-030
V484	6CB6		154-030
V620	6DQ6		154-277
V634	6BL8/ECF80		154-278
V659	5651		154-052
V692	5642		154-051
V859	T5030-2 CRT Standard Phosphor		*154-265

Type 503
Mechanical Parts List

	Tektronix Part Number
ADAPTER, 3 WIRE TO 2 WIRE	103-013
ANGLE, FRAME TOP LEFT	122-060
BAR, 3/16 x 1/2 x 1 3/4 W/2 8-32 TAPPED HOLES	381-073
BAR, EXT. TOP SUPPORT W/HANDLES	Use 381-229
BASE, ALUM., DIECAST	432-022
BRACKET, SP. PHOS. BRONZE CRT SPRING	406-239
BRACKET, CRT SUPPORT	406-569
BRACKET, ATTENUATOR SWITCH LEFT	406-571
BRACKET, ATTENUATOR SWITCH RIGHT	406-572
BRACKET, VERT. ATTENUATOR CAP MTNG.	406-573
BRACKET, HORIZ. ATTENUATOR CAP MTNG.	406-574
BRACKET, TRANSFORMER (SN 1100-up)	406-583
BUSHING, 3/8-32 x 9/16 x .412	358-010
BUSHING, NYLON 11/16 x 7/16	358-025
BUSHING, NYLON (FOR 5 WAY BINDING POST)	358-036
CABLE, HARNESS, MAIN CHASSIS SN 101-269	179-407
CABLE, HARNESS, V. A. #1	179-408
CABLE, HARNESS, V. A. #2	179-409
CABLE, HARNESS, HORIZ. A. #1	179-410
CABLE, HARNESS, HORIZ. A. #2	179-411
CABLE, HARNESS, 100 V	179-412
CABLE, HARNESS, F & I SN 101-269	179-413
CABLE, HARNESS, F & I SN 270-up	179-424
CABLE, HARNESS, MAIN CHASSIS SN 270-399	179-442
CABLE, HARNESS, MAIN CHASSIS SN 400-up	179-470
CABLE, HARNESS, MULT./HORIZ. SW. SN 471-up	179-475
CAP, FUSE	Use 200-582
CAP, BINDING POST 3/8 x 11/32	200-103
CAP, BINDING POST 3/8 x 27/32	200-182
CAP, INSULATION, FUSE HOLDER SN 101-3969X	200-237
CAP, INSULATION (POTS)	200-238
CAP, POT 1 x .390	200-247
CHASSIS, MAIN	441-316
CLAMP, CABLE 5/16" PLASTIC (HALF)	343-042

Mechanical Parts List *(continued)*

	Tektronix Part Number
CLAMP, #20 WIRE	343-043
CLAMP, TUBE TYPE 3 X2320-up	343-074
CONNECTOR, CABLE CRT, PIN	131-049
CONNECTOR, CABLE END 16 CONT. FEMALE	131-076
CONNECTOR, CHASSIS MOUNT COAX 1 CONT. FEMALE	131-081
CONNETOR, CABLE END VAC. TUBE	131-142
COUPLING, POT WIRE STEEL	376-014
COVER, GRATICULE	Use 200-382
COVER, POT & SWITCH	200-152
FASTENER, SNAP DOUBLE PRONGED DELRIN	214-153
FILTER, LIGHT GREEN PLEX	378-514
GRATICULE, 5"	331-056
GRATICULE, 5" UNSCRIBED	331-105
GROMMET, RUBBER 5/16	348-003
GROMMET, RUBBER 3/8	348-004
GROMMET, RUBBER 1/2	348-005
GROMMET, RUBBER 3/4	348-006
GROMMET, POLYPROPOLENE, SNAP-IN	348-031
HOLDER, FUSE	352-010
HOLDER, CORD	352-028
KNOB, SMALL RED 1/8 INSERT HOLE	366-031
KNOB, SMALL RED 3/16 INSERT HOLE	366-032
KNOB, SMALL RED 1/8 HOLE PART WAY	366-038
KNOB, LRG. BLK. 1/4 HOLE THRU	366-040
KNOB, LRG. BLK. 1/4 HOLE PART WAY	366-042
KNOB, SMALL BLK. 1/4 HOLE PART WAY	366-044
KNOB, LRG. BLK. .250 HOLE THRU	366-058
KNOB, SMALL BLK. W/.250 ID	366-066
KNOB, SMALL GREY W/INSERT	366-101
LOCKWASHER, INT. #4	210-004
LOCKWASHER, INT. #6	210-006
LOCKWASHER, EXT. #8	210-007
LOCKWASHER, INT. #8	210-008
LOCKWASHER, INT. #10	210-010
LOCKWASHER, POT INT. 3/8 x 1/2	210-012
LOCKWASHER, INT. 3/8 x 11/16	210-013
LOCKWASHER, NO. 5 SPRING	210-017

Mechanical Parts List *(continued)*

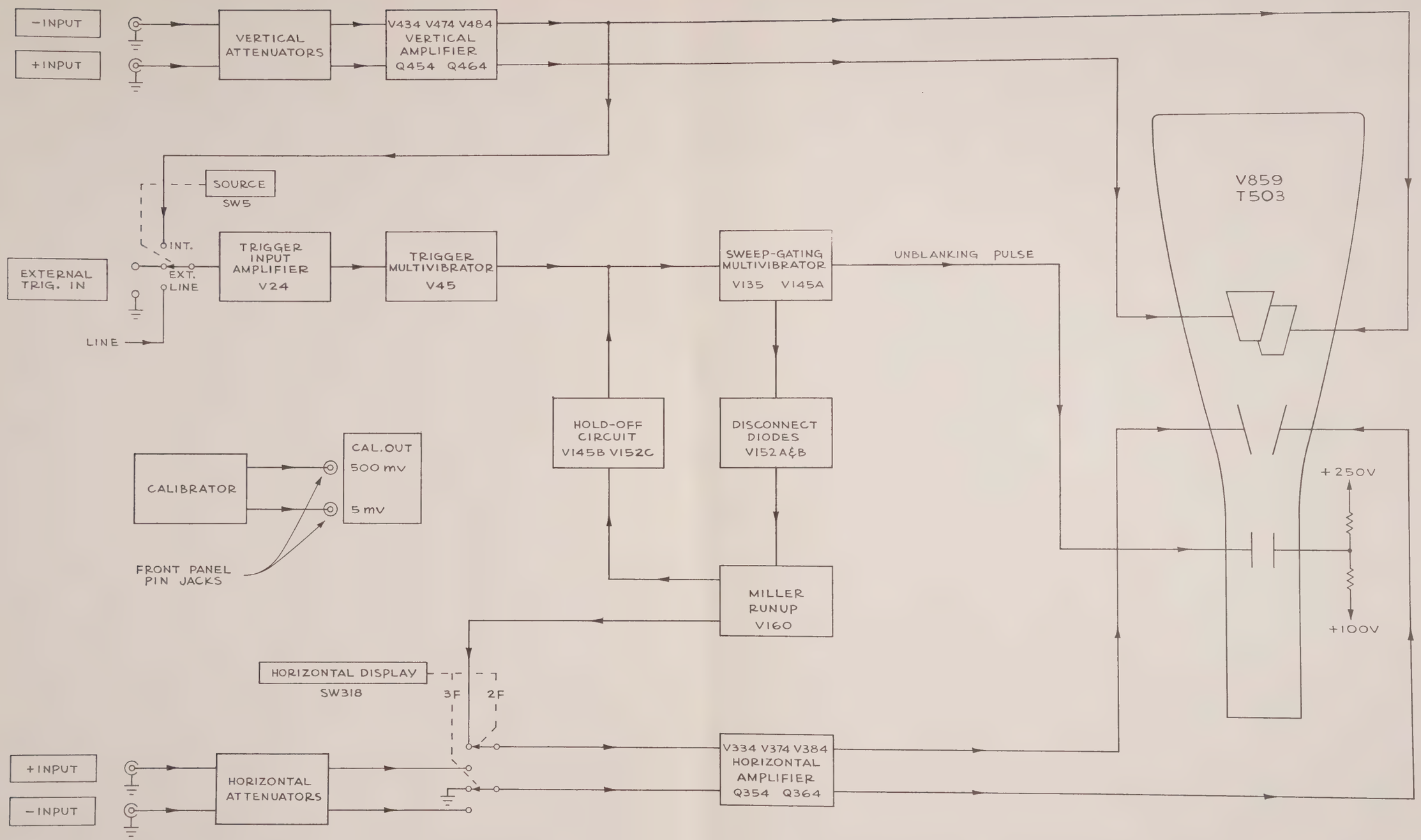
	Tektronix Part Number
LUG, SOLDER, SE4	210-201
LUG, SOLDER, SE6 W/2 WIRE HOLES	210-202
LUG, SOLDER, SE10 LONG	210-206
LUG, SOLDER, POT PLAIN	210-207
LUG, SOLDER, 1/4 HOLE LOCK ROUND PERIMETER	210-223
NUT, HEX 4-40 x 3/16	210-406
NUT, HEX 6-32 x 1/4	210-407
NUT, HEX 8-32 x 5/16	210-409
NUT, HEX, 3/8-32 x 1/2	210-413
NUT, HEX 15/32-32 x 9/16	210-414
NUT, KNURLED GRATICULE	210-424
NUT, HEX 10-32 x 3/8 x 1/8	210-445
NUT, HEX 1/4-28 x 3/8 x 3/32	210-455
NUT, KEPS 6-32 x 5/16	210-457
NUT, KEPS 8-32 x 11/32	210-458
NUT, HEX 1/4-32 x 3/8 x 3/32	210-465
NUT, SWITCH 12 SIDED	210-473
NUT, HEX 3/8-32 x 1/2 x 11/16	210-494
NUT, CRT ROTATOR 10-32 x 3/8	210-502
NUT, CRT ROTATOR SECURING 21-32 x 2 1/2 TAPPED 6-32 BOTH ENDS	210-503
NUT, HEX 10-32 x 3/8 x 1/8	210-564
NUT, KEPS STEEL 10-32 x 3/8	220-410
PANEL, FRONT SN 101-269	333-601
PANEL, FRONT (NO ASTIGMATISM CONTROL SLOT) SN 270-up	333-606
PLATE, 9/16 x 1 9/32 GROUND PLATE OPEN END	386-427
PLATE, 15/16 x 2 5/16 SWITCH MOUNTING	386-450
PLATE, FRONT SUBPANEL	387-198
PLATE, REAR SUBPANEL	387-199
PLATE, REAR OVERLAY	387-200
PLATE, CAB. SIDE	387-201
PLATE, CAB. BOTTOM	387-202
PLATE, CRT SOCKET BACK	387-344
POST, BINDING 5 WAY STEM & CAP ASS'Y, FLUTED CAP	129-036
POST, BINDING ASS'Y 355-507 & 200-182	129-051
POST, BINDING ASS'Y 355-507 & 200-103	129-053
RING, LOCKING SWITCH	354-055

	Tektronix Part Number
RING, SECURING SN 101-2379	Use 050-063
RING, SECURING SN 2380-up	354-178
RING, CLAMPING ASS'Y 354-079 & 210-502	354-103
ROD, 1/8 x 5 15/16	384-209
ROD, HEX 1/4 x 9/32 TAPPED 6-32 THRU	385-127
ROD, SUPPORT 5/16 x 3 1/4 TAPPED 6-32 ONE END	385-147
SCREW, 4-40 x 3/16 BHS	211-007
SCREW, 4-40 x 1/4 BHS	211-008
SCREW, 5-40 x 3/16 PAN HS	211-029
SCREW, 4-40 x 5/16 FHS, PHILLIPS	211-038
SCREW, 6-32 x 5/16 BHS	211-507
SCREW, 6-32 x 3/8 FHS	211-509
SCREW, 6-32 x 3/8 BHS	211-510
SCREW, 6-32 x 1/2 BHS	211-511
SCREW, 6-32 x 5/8 BHS	211-513
SCREW, 6-32 x 5/16 PAN HS W/LOCKWASHER	211-534
SCREW, 6-32 x 5/16 FHS, 100°, CSK, PHILLIPS	211-538
SCREW, 6-32 x 5/16 RHS	211-543
SCREW, 6-32 x 1 1/4 TRUSS HS, PHILLIPS	211-545
SCREW, 6-32 x 3/8 FHS, 100°, CSK, PHILLIPS	211-559
SCREW, 6-32 x 1 RHS	211-560
SCREW, 6-32 x 3/8 FH CAP HEX SOC	211-561
SCREW, 8-32 x 5/16 BHS	212-004
SCREW, 8-32 x 3/8 BHS	212-023
SCREW, 8-32 x 3/8 TRUSS HS, PHILLIPS	212-039
SCREW, 8-32 x 3/8 FHS, 100°, PHILLIPS	212-040
SCREW, 8-32 x 1 1/2 STEEL PHILLIPS W/OVAL CSK HEAD	212-061
SCREW, 10-32 x 1/2 OHS	212-512
SCREW, 10-32 x 1 3/4 HHS	212-517
SCREW, 12-24 x 1/2 OHS	212-561
SCREW, THREAD CUTTING 4-40 x 5/16 RHS, PHILLIPS	213-034
SCREW, THREAD CUTTING 6-32 x 3/8 TRUSS HS, PHILLIPS	213-041
SCREW, THREAD CUTTING 5-32 x 3/16 PHS, PHILLIPS	213-044
SCREW, THREAD CUTTING 4-40 x 5/16 PHS	213-045
SCREW, THREAD FORMING #4 x 1/4 Type B	213-088

	Tektronix Part Number
SCREW, THREAD FORMING 6-32 x 3/8 THS	213-104
SCREW, 2-32 x 5/16 RHS, PHILLIPS	213-113
SHIELD, TUBE 1 1/32 ID W/SPRING 1 15/16 HI	337-008
SHIELD, 5" GRATICULE LIGHT	337-187
SHIELD, STEEL 1/32 x 1 1/4 3/8 CENTER HOLE	337-248
SHIELD, CRT	337-364
SHIELD, F & I	337-365
SHIELD, 5" GRATICULE LIGHT R/B 337-187	337-375
SOCKET, STM7G	136-008
SOCKET, STM8G	136-011
SOCKET, STM9G	136-015
SOCKET, STM9S W/SHIELD W/O CENTER PIN	136-022
SOCKET, GRATICULE LIGHT W/GROUND LUG	136-035
SOCKET, CRT 14 PIN W/LEADS R/B 136-103	136-076
SOCKET, BANANA JACK ASS'Y, BLACK	136-138
SOCKET, 9 PIN SHIELDED BASE W/SHOCK MTNG. SPRING	136-087
SOCKET, 4 PIN TRANSISTOR	136-095
SOCKET, REWORKED CRT 14 PIN W/LEADS	136-103
SPACER, NYLON MOLDED 3/16 FOR CERAMIC STRIPS	361-007
SPACER, NYLON MOLDED 5/16 FOR CERAMIC STRIPS	361-009
STRIP, FELT	124-022
STRIP, CERAMIC 3/4 x 2 NOTCHES, CLIP MOUNTED	124-086
STRIP, CERAMIC 3/4 x 4 NOTCHES, CLIP MOUNTED	124-088
STRIP, CERAMIC 3/4 x 7 NOTCHES, CLIP MOUNTED	124-089
STRIP, CERAMIC 3/4 x 9 NOTCHES, CLIP MOUNTED	124-090
STRIP, CERAMIC 3/4 x 11 NOTCHES, CLIP MOUNTED	124-091
STRIP, CERAMIC 2 NOTCHES 1 CLIP	124-119
STUD, STEEL	355-049
STUD, STAINLESS 8-32 x 4 1/2	355-070
TAG, VOLTAGE RATING	334-649
TUBE, SPACING .180 x 1/4 x 7/32 (ONE END CSK) R/B 385-127	166-107
WASHER, STEEL 6L x 3/8 x .032	210-803
WASHER, STEEL 8S x 3/8	210-804
WASHER, RUBBER	210-816

RADIATION DEPARTMENT FELTHAM

	Tektronix Part Number
WASHER, STEEL #10	210-833
WASHER, STEEL .390 x 9/16	210-840
WASHER, RUBBER FOR FUSE HOLDER	210-873
WASHER, INSULATING BLACK 3/8 x 1/10 (SHOULDERED)	210-895
WASHER, RED FIBER	210-906
WASHER, TEFLON 5/8 x .191 x .025	210-917

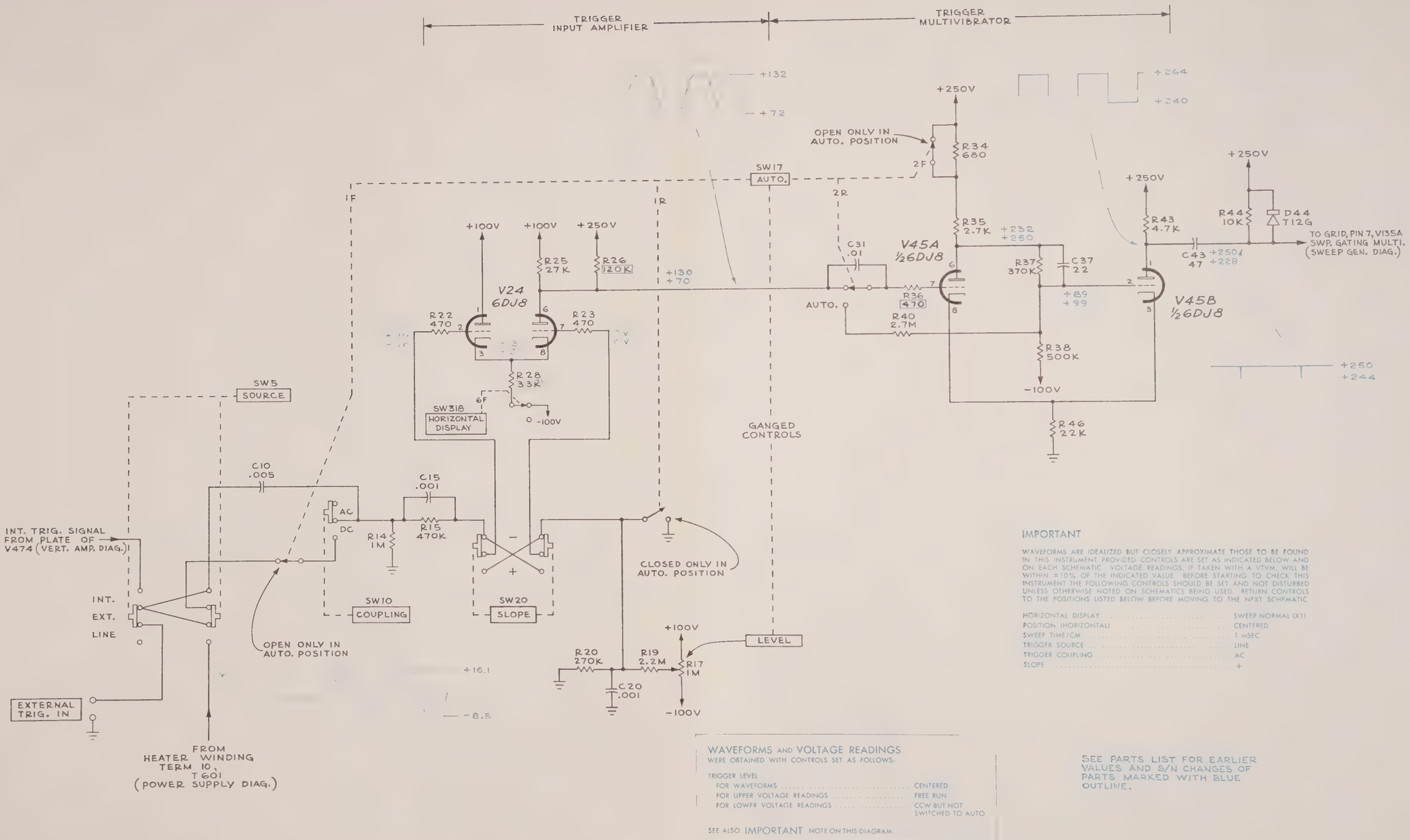


GAB
8-5-62

TYPE 503 OSCILLOSCOPE

A1

BLOCK DIAGRAM



IMPORTANT

WAVEFORMS ARE IDEALIZED BUT CLOSELY APPROXIMATE THOSE TO BE FOUND IN THIS INSTRUMENT PROVIDED CONTROLS ARE SET AS INDICATED BELOW AND ON EACH SCHEMATIC. VOLTAGE READINGS, IF TAKEN WITH A VTVM, WILL BE WITHIN ±10% OF THE INDICATED VALUE. BEFORE STARTING TO CHECK THIS INSTRUMENT THE FOLLOWING CONTROLS SHOULD BE SET AND NOT DISTURBED UNLESS OTHERWISE NOTED ON SCHEMATICS BEING USED. RETURN CONTROLS TO THE POSITIONS LISTED BELOW BEFORE MOVING TO THE NEXT SCHEMATIC

HORIZONTAL DISPLAY	SWEEP NORMAL (X1)
POSITION (HORIZONTAL)	CENTERED
SWEEP TIME/CM	1 mSEC
TRIGGER SOURCE	LINE
TRIGGER COUPLING	AC
SLOPE	+

WAVEFORMS AND VOLTAGE READINGS

WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:

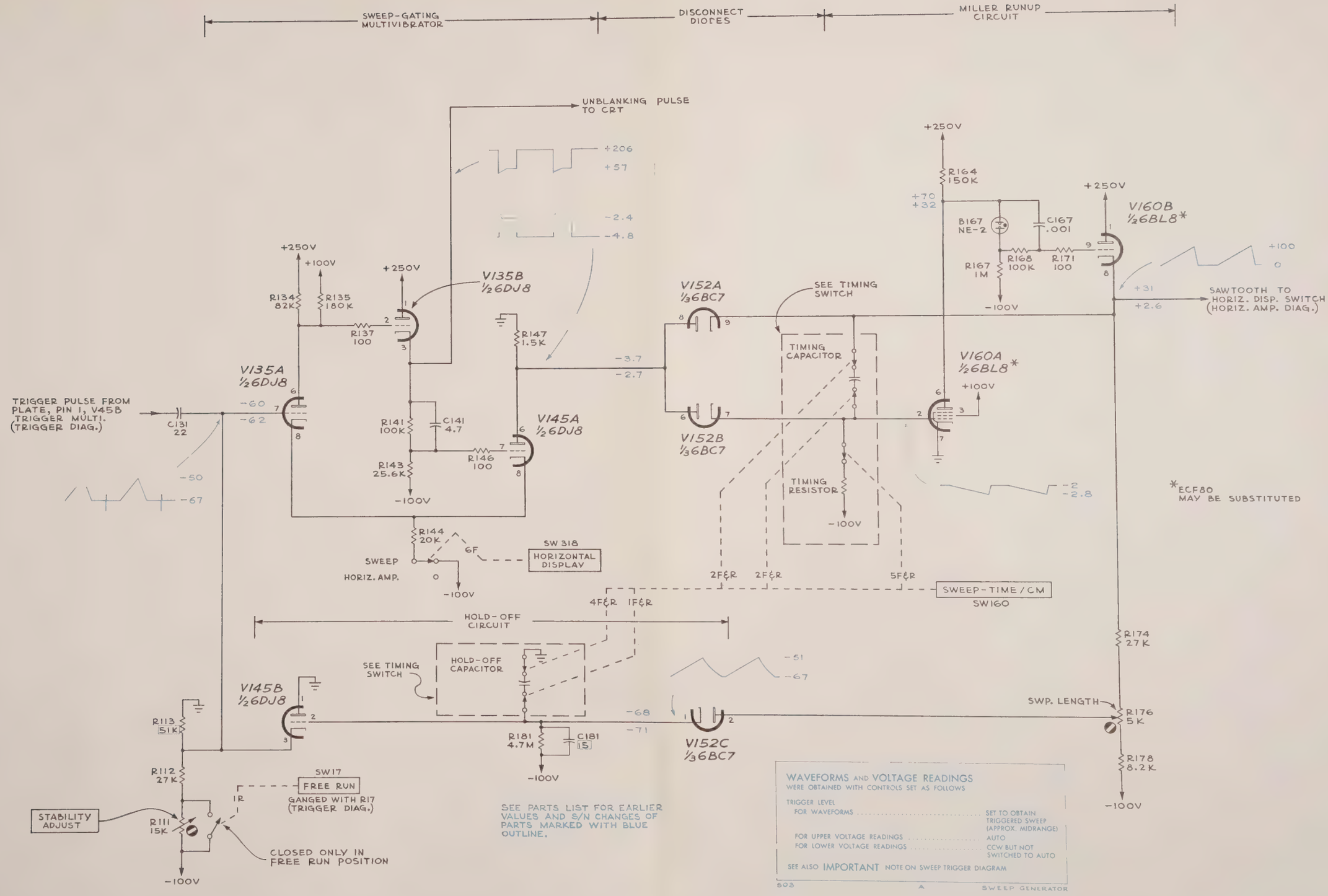
TRIGGER LEVEL	
FOR WAVEFORMS	CENTERED
FOR UPPER VOLTAGE READINGS	FREE RUN
FOR LOWER VOLTAGE READINGS	CCW BUT NOT SWITCHED TO AUTO

SEE ALSO IMPORTANT NOTE ON THIS DIAGRAM

503 A SWEEP TRIGGER

SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE.

GAB 364

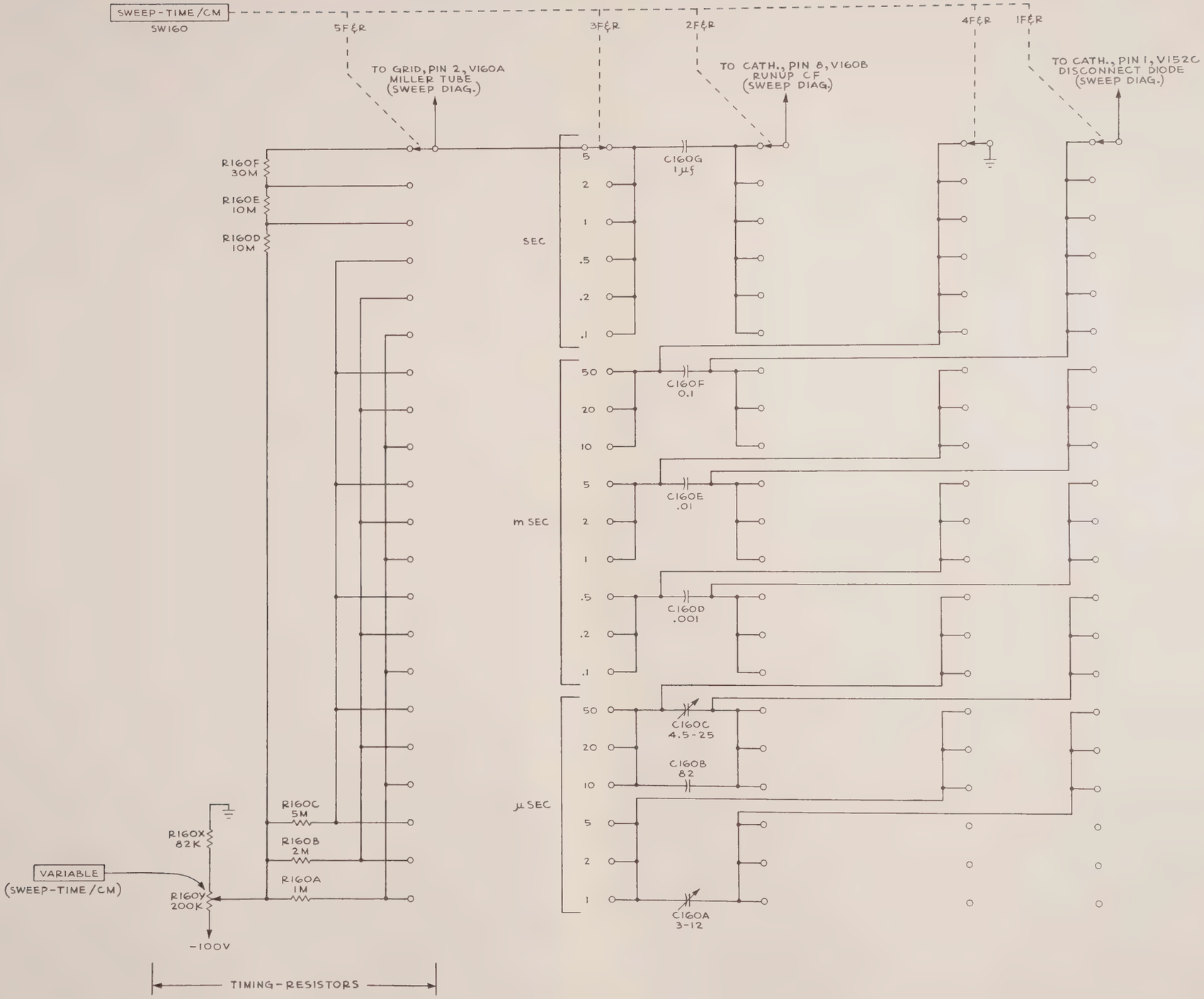


TYPE 503 OSCILLOSCOPE

C4

SWEEP GENERATOR

GAB
364

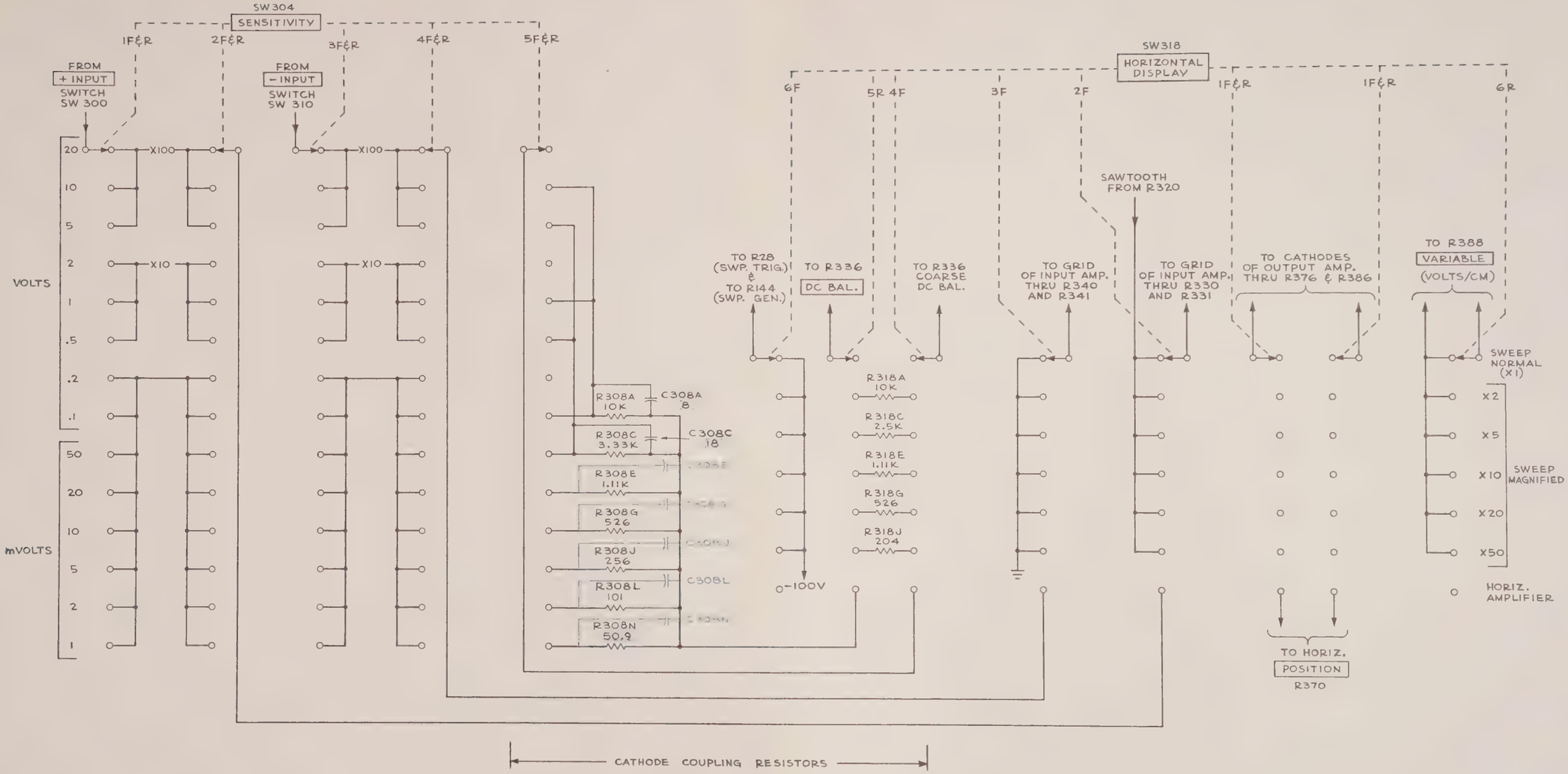


TYPE 503 OSCILLOSCOPE

A1

TIMING SWITCH

8-18-62



SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE.

9 & B
363

HORIZONTAL DISPLAY SWITCH
HORIZONTAL AMPLIFIER ATTENUATOR SWITCH

SAWTOOTH FROM CATH., PIN 8, V160B (SWEEP DIAG.)

R320 193K

R321 3.92K

R322 500

SWP. CAL.

+100V

R326 4.7M

R327 180K

HORIZONTAL DISPLAY SW318

2F 5R 4F 3F 1F&R 1F&R 6R

SW300

+ INPUT

C300 .022

AC DC GND.

ATTENUATORS

HORIZ.AMP.

R306 1M

C306 3-12

SENSITIVITY SW304

1F&R 2F&R 3F&R 4F&R 5F&R

SWP./MAG. REGIS.

R339 1K

C308

R308

R318

R319 21.5K

-100V

+42

+100V

R334 50K

+40 +40

C330 .005

R331 470

R330 100K

SWEEP

0V 0V

V334A ½6DJ8

DC BAL.

+1.3 +1.3

R337 68

R336 250

C336 .005

R338 38.3K

HORIZ. AMP.

SWEEP

L319 4.7 mh

TO X BELOW

C350 47

1 MV GAIN ADJ

R360 20K

C353 0.1

+100 V

R352 8.2K

R353 10K

D352 T12G

R354 3.3K

+42 +42

Q354 2N1749

C356 1.5-7

C357 12

R356 390K

R357 12.5K

R358 1M

+22 +21

+250V

+205

L373 3.9 mh

R373 30K

+100V

TO LEFT HAND DEFLECTION PLATE

+65 +210

+100

V374 6CB6

R371 100

+23 +23

R376 15K

C390 1.0pf

VARIABLE VOLTS/CM

R388 2.5K

SWEEP

HORIZ. AMP.

R370 2X20K

POSITION

-100V

R377 12K

-100V

.2V GAIN ADJ.

R387 12K

R378 750

R379 402

R386 15K

V384 6CB6

R381 100

+23 +23

+100V

TO RIGHT HAND DEFLECTION PLATE

R383 30K

L383 3.9mh

+250V

R368 1M

R348 38.3K

R346 250

R347 68

C346 .005

COARSE DC BAL.

+1.3 +1.3

C340 .005

R340 100K

R341 470

0V 0V

V334B ½6DJ8

R350 1.5K

C360 47

R366 390K

C367 12

R367 12.5K

D362 T12G

Q364 2N1749

+21 +22

R344 50K

+40 +40

+100V

R316 1M

C316 3-12

SW310

- INPUT

C310 .022

AC DC GND.

ATTENUATORS

SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE.

VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS

BOTH HORIZONTAL INPUTS	GND
SENSITIVITY	.2 VOLTS/CM
HORIZONTAL POSITION	
FOR UPPER VOLTAGE READINGS	CW
FOR LOWER VOLTAGE READINGS	CCW
HORIZONTAL DISPLAY	HORIZ AMPLIFIER (SWEEP DISABLED)

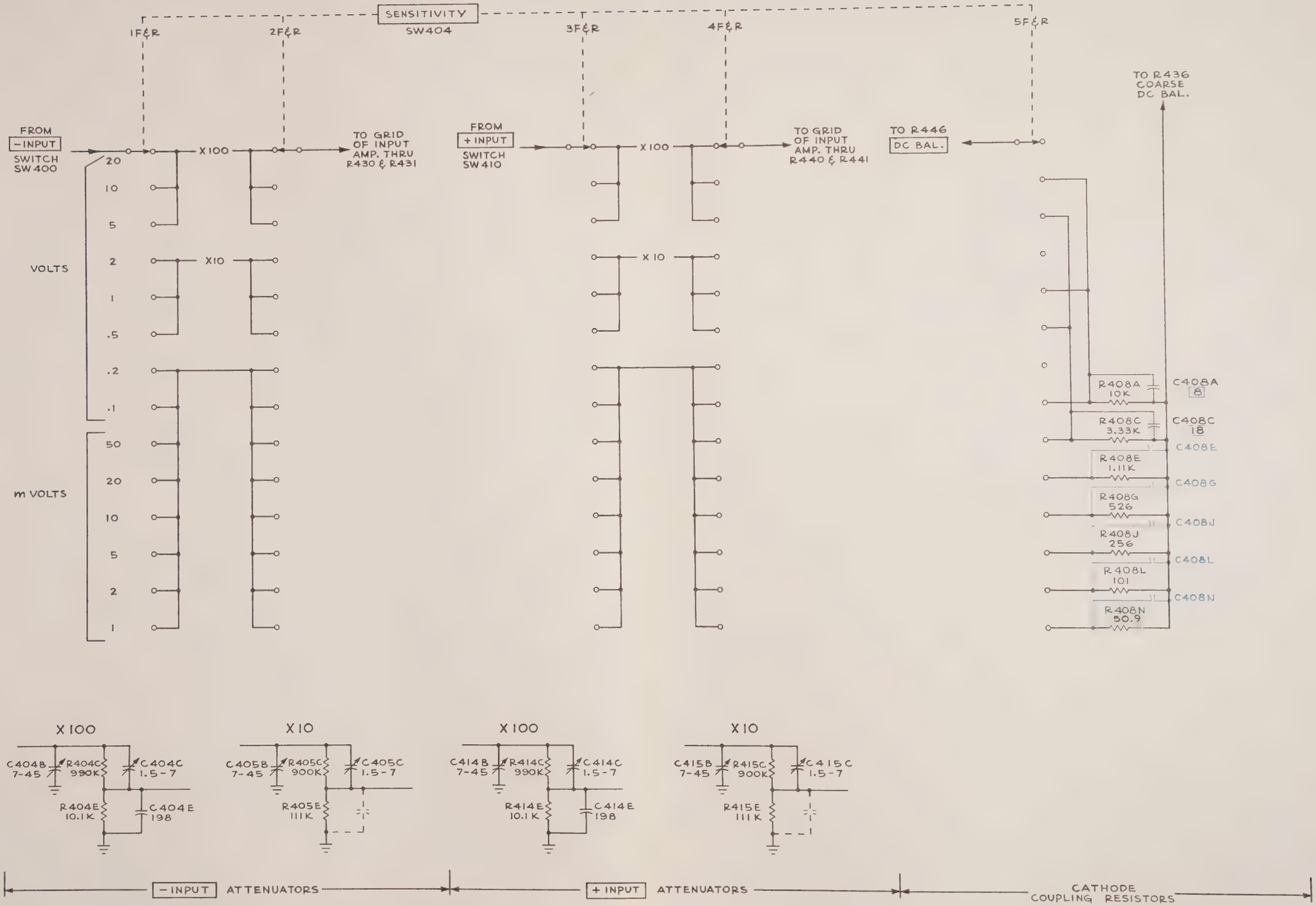
SEE ALSO IMPORTANT NOTE ON SWEEP TRIGGER DIAGRAM

503 A HORIZ. AMP

G&B 364

TYPE 503 OSCILLOSCOPE

HORIZONTAL AMPLIFIER



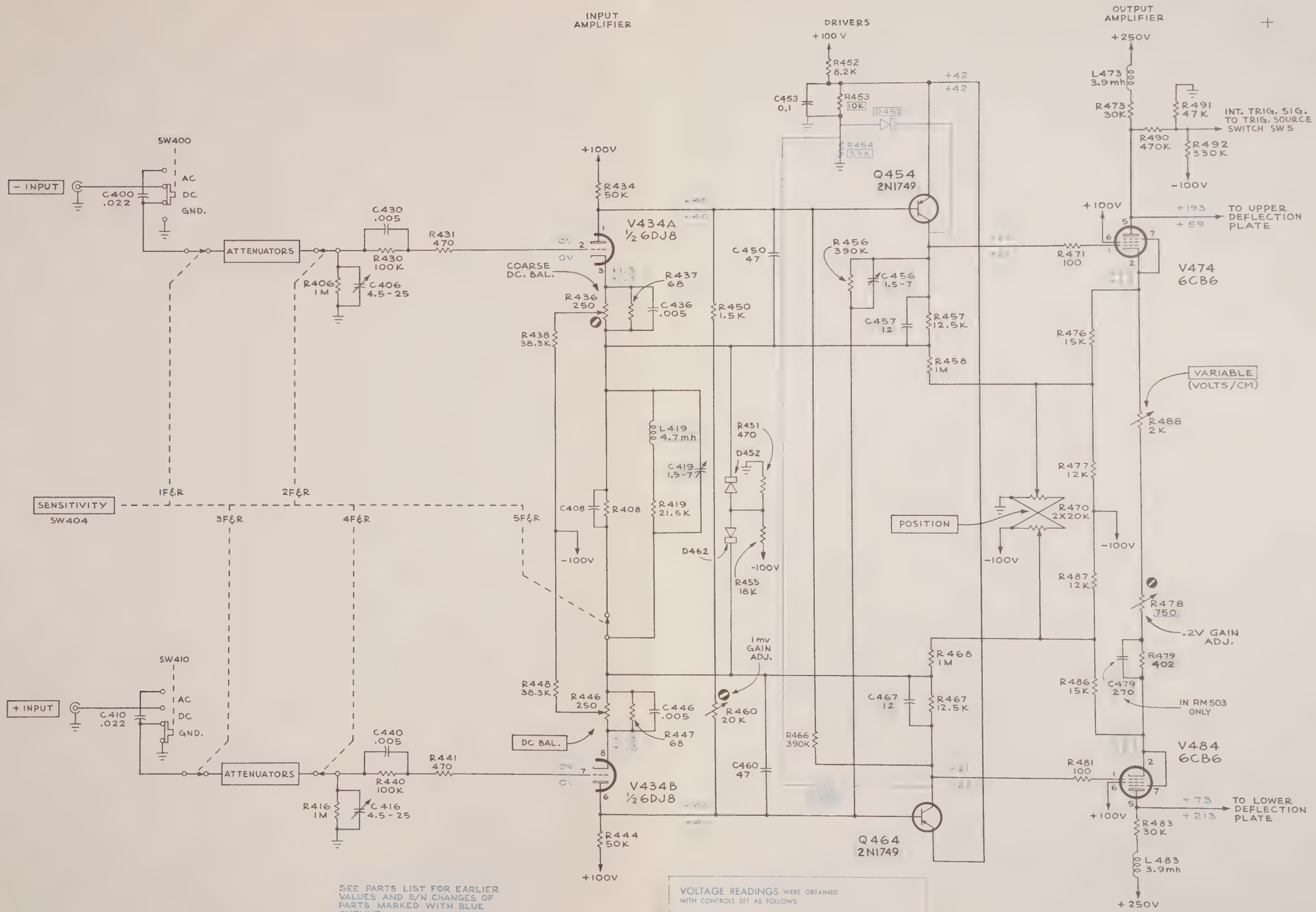
TYPE 503 OSCILLOSCOPE

F2

SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE.

VERTICAL AMPLIFIER ATTENUATOR SWITCH

GAB
364



SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE.

VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS

BOTH INPUTS	GND
SENSITIVITY	.2 VOLTS/CM
VERTICAL POSITION	
FOR UPPER VOLTAGE READINGS	CW
FOR LOWER VOLTAGE READINGS	CCW

SEE ALSO IMPORTANT NOTE ON SWEEP TRIGGER DIAGRAM

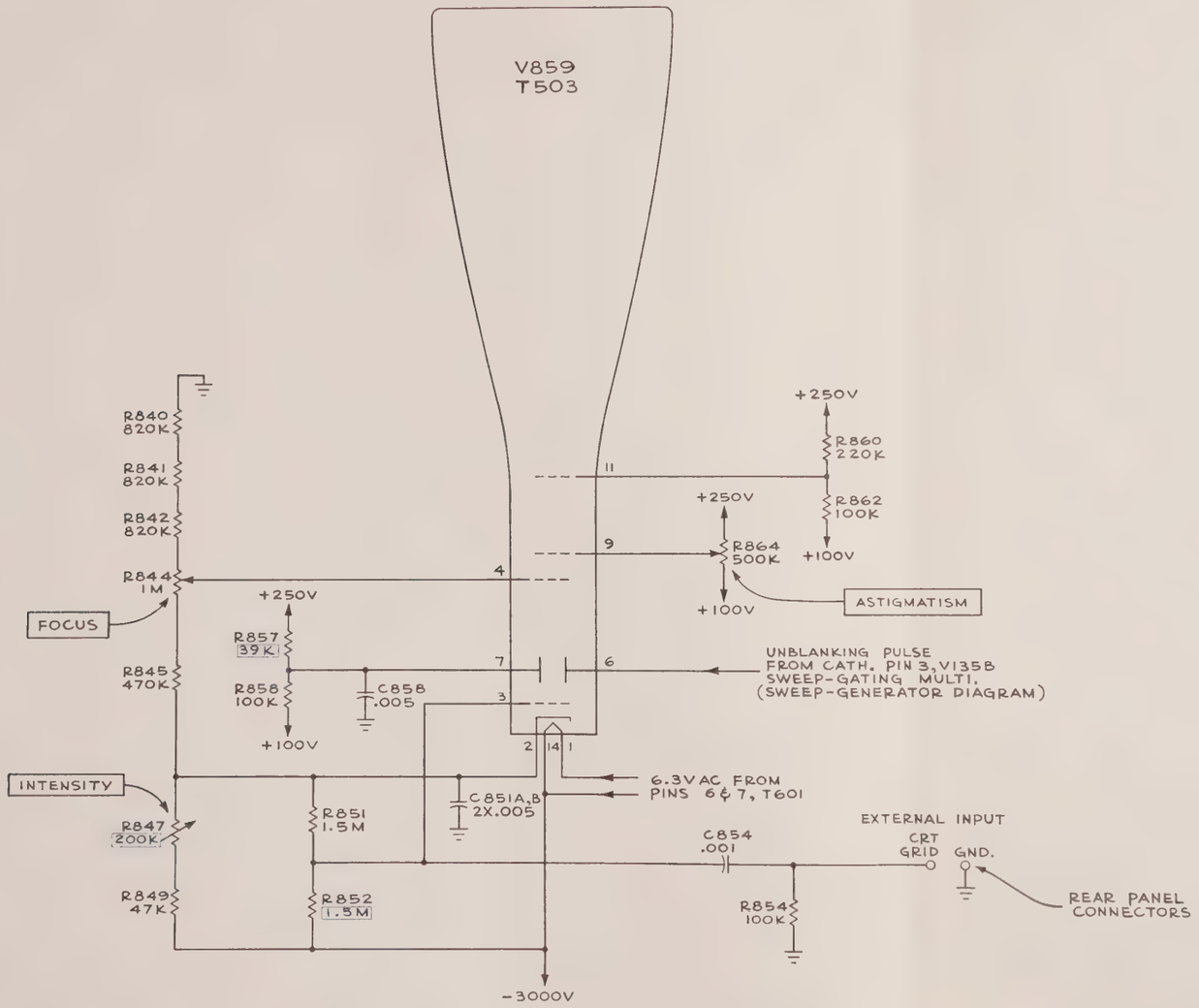
503 A VERT. AMP

GAB 364

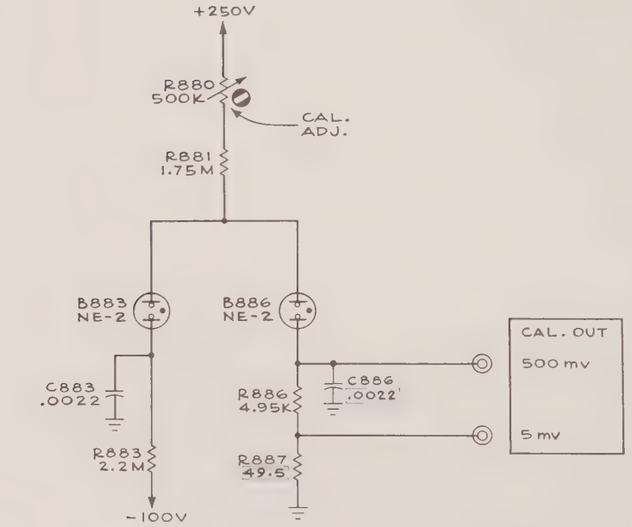
TYPE 503 OSCILLOSCOPE

VERTICAL AMPLIFIER

CRT CIRCUIT



CALIBRATOR



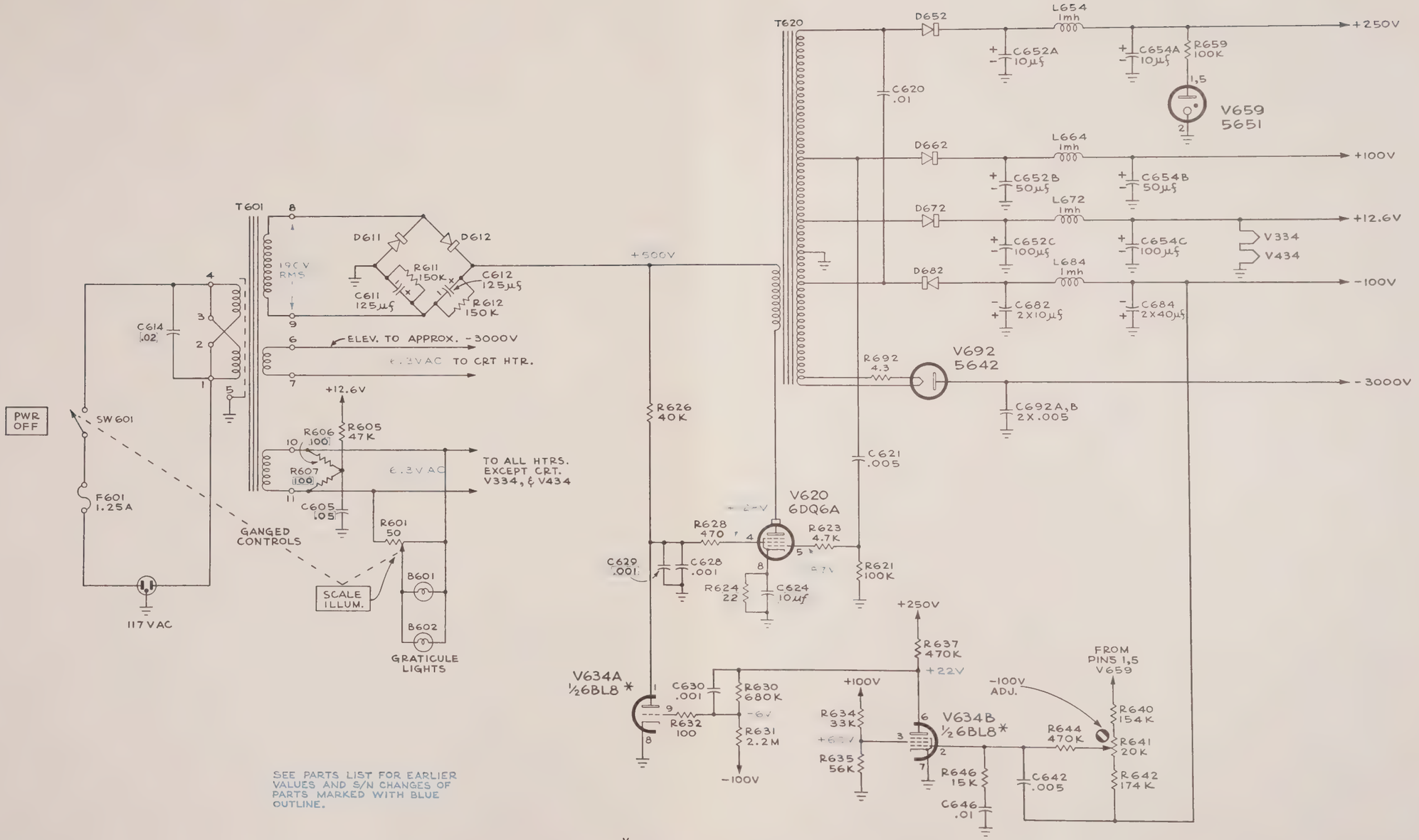
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE.

GAB
364

TYPE 503 OSCILLOSCOPE

E,

CRT CIRCUIT & CALIBRATOR



SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE.

* ECF80 MAY BE SUBSTITUTED

VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:

LINE VOLTAGE	117 V 60 CPS
TRIGGER LEVEL (SWEEP DISABLED)	CCW BUT NOT SWITCHED TO AUTO

SEE ALSO IMPORTANT NOTE ON SWEEP TRIGGER DIAGRAM

503 A POWER SUPPLY

G3

G.A.B. 364

TYPE 503 OSCILLOSCOPE

POWER SUPPLY

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

TYPE 503 - TENT. S/N 4230
TYPE RM503 - TENT. S/N 2970

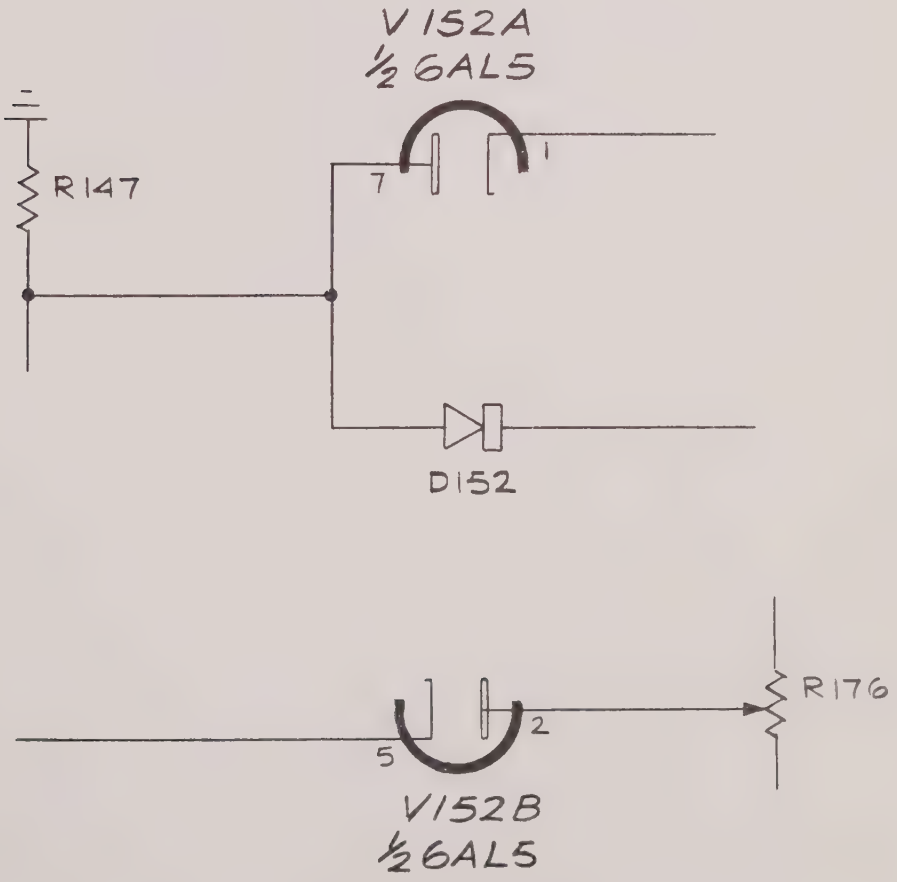
PARTS LIST CORRECTION

CHANGE TO:

V152	6AL5		154-016

ADD:

D152	Silicon	Tek Spec	152-173



503/RM PART. SWEEP GENERATOR

TYPE 503 - TENT. S/N 4090

PARTS LIST CORRECTION

CHANGE TO:

C406	7-45 μμf	Cer.	Var.	281-012
C416	7-45 μμf	Cer.	Var.	281-012